MAP OF SOUTH AMERICA.

PHYSICS

OF THE

INFECTIOUS DISEASES.

COMPREHENDING A DISCUSSION OF CERTAIN PHYSICAL PHENOMENA IN CONNECTION WITH THE ACUTE INFECTIOUS DISEASES.

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TO

SR. DON ADOLFO YBAÑEZ,

LATE MINISTER OF FOREIGN RELATIONS OF THE REPUBLIC OF CHILE.

Sir: This little book has grown out of a residence in a country full of interest to the scientist, philosopher, and historian; and among a people progressive, enlightened, and hospitable to a proverbial extent. For the material it contains, the writer is largely indebted to your individual and official aid, whereby he was enabled to avail himself of access, not alone to the scientific, but likewise to the medical institutions of the Republic.

Filled with pleasant recollections of the country and its people; with gratitude for the handsome treatment he received at their hands; and animated by a personal friendship for yourself, only to be terminated when the earthquakes finally disappear from your beautiful Chile (*hasta mi muerte, Señor*), this volume is fittingly offered to you in dedication, by

The Author.

PREFATORY NOTE.

SEVERAL years since, while the author, as a member of the Kansas State Geological Survey, in charge of the departments of Botany and Sanitary Relations, was collecting material for a report upon those subjects, to be incorporated in the general report of the Survey, his attention was directed to a circumstance which appeared to him of singular character, viz: the greater or less prevalence of certain of the acute infectious diseases, in pretty constant association with certain general physical conditions. The association was not of a character so pronounced, however, as to enable the reporter to trace with any special definiteness, the direct lines of cause and effect.

At a subsequent date, being called to reside in South America, in occupancy of a position (that of U. S. Minister to the Republic of Chile), which not only gave him ample leisure, but afforded him unusual facilities for study and observation, he became confirmed in some of the convictions which had previously impressed themselves upon him; while many new lines of thought developed themselves as natural suggestions, flowing from the very remarkable, and very interesting physical circumstances of

that portion of the world falling under description in the following pages. One of the author's purposes in the preparation of this small, and, as he fears, incomplete volume, has been to develop the chain of reasoning upon the specific causation of the important class of diseases before mentioned, which has grown out of his own estimate of all the factors, involved in a solution of the intricate questions underlying the ætiology of these maladies.

Apart from this purpose, however, he has had two other objects in view, of far greater value to the profession than the statement of his own opinions. These are: firstly, to furnish medical information concerning a region, which in a medical sense, is emphatically a *terra incognita*, by reason of the almost entire lack of accessible literature pertaining to its medical aspects; and secondly, to stimulate the general body of the medical profession to a more extended study of the physical laws and operations of nature, without a knowledge of which, we can never hope to impart to the simple art of medicine, any of the features of an exact and recognized science.

Some three hundred years ago, Dr. Radcliffe, an eccentric London physician, declared that he could write the whole art of medicine upon a single sheet of paper; and in our own day there seems to exist a tendency, upon the part of many mere practitioners, to cultivate too exclusively, a facility for ready and varied prescription writing. Notwithstanding the impediment to genuine medical progress

offered by him, who sees but a question of *dosage* in all cases of sickness, there is a constant and unmistakable advance of the general profession, in the direction of lifting it from the furrows of a narrow routine, and of placing it upon an eminence, from which it may command an unobstructed view of its entire surroundings. The author, therefore, has no apology to make for the discussion of subjects, which, upon a superficial view, would seem to have no immediate relationship with the direct topics of medical inquiry.

His purpose, however, has been to give to his remarks upon the various subjects treated, more of a suggestive character, than of didactic positiveness. If there shall be some to open the book with a running glance at its pages, in expectation of finding the long-sought secret of *specific* medication, and failing in this, to lay it aside with the exclamation, *Nil novi sub sole*, the author trusts there will be not a few to carefully follow its line of reasoning to the close; and to these, he ventures to believe, there will be presented much material worthy of the most careful thought.

It is only within a comparatively recent period that the present views, concerning what the author has been compelled to call, by way of distinction, the *general* or *original force* or *energy* of nature, have been developed; and so far as relates to the mysterious agency, so long designated as the *vital force*, and more recently, as the *nervous force*, the ground may be said to be almost unbroken. And yet it

must be apparent to every reflecting mind, that the very richest developments of medicine are to be obtained in following a lead, which must inevitably carry the investigator to the very centre of his subject; for within that inscrutable something, which the author calls *vital gravitation*, and the *vital energy* in its most restricted sense, is to be found enthroned the secret of the *Life principle*, the mystery of *Generation*, and the wonders of *Distinct Species*.

Through the woof and warp of his argument, the author lays no claim to absolute perfection in the thread of detail. The touchstone of Time may level his theories to the dust, and show them to be as insubstantial as "the baseless fabric of a vision"; the works of abler writers may consign this little book to oblivion; and yet there are principles herein set forth which neither time nor authors can disturb; as there are also facts underlying the structure the author has attempted to build, which must remain immutably fixed through all the coming cycles of the future, and cease to be facts only, when the wreck of matter and the crash of worlds shall announce the end of present laws, and the termination of all existences resting upon them.

C. A. L.

No. 99 Ashland Avenue, Chicago,
May 1, 1878.

CONTENTS.

PART I.

INTRODUCTORY REMARKS.

PART II.

PHYSICAL ASPECTS OF THE PACIFIC COAST OF SOUTH AMERICA.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

PART III.

MEDICAL ASPECTS OF THE PACIFIC COAST OF SOUTH AMERICA.

PART IV.

THE PHYSICS OF SPECIFIC CAUSATION.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

PART V.

THERAPEUTICS OF THE INFECTIOUS DISEASES.

PART VI.

THE QUESTION OF ENERGY AS RELATED TO GENERAL DISORDERS.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

PHYSICS

OF THE

INFECTIOUS DISEASES.

PART I.

INTRODUCTORY REMARKS.

General Observations.

A class of diseases, variously denominated in later times, zymotic, infectious, contagious, miasmatic, miasmatic-contagious, etc. etc., ravaged the earliest ages of which we have any authentic record; and have transmitted themselves, probably under the identical features and aspects which originally characterized them, through all the eventful centuries of the past, and now stand before our own generation as a monument of human mortality, which has escaped the changes of time upon the one hand, and, in great part, the assaults of advancing science upon the other.

That such an important group of diseases should have stimulated special investigation and study is not to be wondered at; and that the hope of the physician has not budded into the full flower of an accomplished fact, though a thing to be regretted, is no cause for a relinquishment of effort. The author of a recent and valuable work upon General Pathology declares that ætiology, or a knowledge of the causes of disease, is one of the weakest chapters of his subject. The necessity for such a declaration seems no

less imperative than to be regretted; and no less true in general terms than unfortunate in practical consequences. This branch of the healing art may safely be said to underlie its whole structure, as within its limits are included the prevention of prospective disease, as also the cure of established morbid action. It thus comprehends the prime subjects of *hygiene* and *therapeutics*, which subjects mark the extreme boundary line of the mere physician's usefulness.

The vital importance of the knowledge of disease-causation, therefore, has always been recognized by the medical practitioner, as well as by the medical philosopher; and the endeavor to lift the veil so darkly covering the complex processes of nature's laboratories, to the end that intelligent effort might supersede empirical experiment in the prevention and treatment of our physical maladies, has been a constant characteristic of enlightened medical research. If the effort have not already been crowned with the full success of the most sanguine desire, a survey of the field from the standpoints of our own day, and that of even fifty years ago, will show a progress entirely justifying the statement, that the first empirical elements of the medical art have been already transformed into the higher features of an extended science, with many established facts entailing precise and demonstrative results.

Some of the immediate and remote causes of morbid action are now as plainly mapped out as rocks and shoals on the navigator's chart; and though the innate characters of *specific* agencies are quite unknown to us, and the developments of our age have been in that inverse order which enables us to see the effect before recognizing the cause, yet our knowledge of the preventive influences of general and

private sanitary measures, the protective power of vaccination and of other positive resources, is much to boast of. As confessed by Wagner, however, in the work before alluded to, the doctrines of specific-disease causation — to the consideration of which this small volume is to be devoted — are still in the rudiments. The subject is so vast in proportions, so intricate in varied relations, and so largely confined to the operations of forces and matter utterly beyond the reach and view of the unaided senses, and therefore only to be approached through the assistance of mechanical and other expedients, that the full consummation of hope, if ever to be realized, is possible only through the accumulative developments of time and patient research.

The Atmosphere as a Medium of Disease-Transmission.

In the search for causative agencies, the atmosphere which envelops our planet has been studied with as much care as the present state of our general knowledge permits; and this not alone with reference to its own inherent constitution, and the manner in which it is affected by the solar heat and the associated questions of aqueous and electrical states, but also as a medium for the transmission of the *contagia* of the infectious class of diseases, which latter undoubtedly proceed from an agency specific and distinctive in character, and with full ability to preserve its own individual type of constitution.

It is in the direction of solving the problem last mentioned that the medical energy of our period is largely expending itself; these being affections which, as before stated, still play a dreaded *role* in the mortality of the human race; while in the past history of the world they have carried desolation to states and defeat to armies; have sub-

verted governments; changed the lines of commerce, and leveled and established empires. Though the attempt to bring into full view and general acknowledgment, the mysterious hosts which carry more terror before them than whole regiments of armed men has not been at all successful, yet it must be admitted that many of the diseases under consideration have been greatly shorn of their evil power; while a careful estimate of the already-accumulated and constantly-increasing mass of observations relating to the circumstances and conditions which enable these legions of destruction to spring into the line of attack, gives some promise of an ability, perhaps, in a not distant future, to erect such barriers as may largely and even effectually stop their ravages, though the producing agents themselves forever remain invisible.

Classification of the Diseases to be Considered.

It is the author's present purpose to discuss the causes of the acute infectious diseases, in their varied relationships and collateral bearings; and as growing out of the line of reasoning which will be developed, to make some observations relating to the general therapeutics of such diseases, intended, however, as elsewhere stated, to have more of a suggestive than other character.

In treating of any subject, medical or non-medical, it seems of the first importance that the terms used in description and discussion should bear a precise and unequivocal signification; otherwise confusion continually arises. The classification and, to a certain extent, the nomenclature of general diseases, originally founded upon the most arbitrary and unscientific bases, have been shifting, periodically, to meet the new ideas and developments concerning the essential nature of morbid action.

This observation is quite true of the specific affections, there being even now a particularly indefinite use of the terms *infectious* and *contagious;* the greater number of pathologists, probably, using the two terms synonymously.

But, within the short space of a decade, a change of classification has been made in this group of diseases, as will be perceived by the following extract from an author, then as now, of the highest rank. Aitken (Practice of Med., 2d Am. Ed. 1866) comprehends, under the head of *zymotic* diseases: "All the principal diseases which have prevailed as *epidemics* or *endemics*—all those which are due to *paludal* or *animal malaria;* and those due to *specific disease poisons,* capable of propagation from one human being to another, and *communicable either by* direct *contact* or indirectly through various channels of human intercourse, contaminating drinking water or infecting the air, *or by animals in a state of disease.* The class also comprehends the diseases that result from the *scarcity and the deterioration of the necessary kinds of food,* from the generation, propagation or existence of *parasitic animals.*"

The following statement, however, probably embodies the most general present usage as to classification of the diseases to be considered.

Infectious *or* contagious diseases are those believed to originate from a peculiar causative agent, which latter, under the proper conditions, is capable of reproduction to an endless and unlimited extent. These conditions may require the causative agent, before being capable of producing the typical disease-form in another person, to have its origin either within or without the human body. In the former case, the specific excitant of disease as between two persons, is called the *contagium;* while in the latter it is usual to designate it as a *miasm.* The contagium is capable of con-

veyance from a diseased individual to a sound or healthy one, and of setting up the type-disease in the latter. Miasm, as being connected with causes entirely outside of the animal organism, makes its impression upon an individual exposed to its influence, and establishes a specific disease within him; but renders him entirely incapable of transmitting it to another. The first class may be represented by small-pox; and the second, by the periodical or malarious fevers.

There exists still a third class of infectious diseases, which belong to neither of the preceding as above defined. These diseases are not conveyed directly from person to person by specific contagium, nor yet have they such an autochthonous origin as render them susceptible of sporadic development. They are represented chiefly by such affections as cholera, and typhoid and yellow fevers. They are supposed to depend upon a poison, which, having produced the typical affection in one person, must undergo a change *outside* of the human body before it can produce the like disease in another person. The nature of this change, whether progressive or retrograde, as regards the new development of the poison, is not stated, of course; the character of the original poison itself being unknown. Upon such a supposition, however, it is sought to explain the alleged fact, that the dejections of a cholera subject are incapable of transmitting that disease while fresh and recent, but acquire that power after the lapse of a certain period of time.

There seems to be an imprecision, however, in the foregoing classification, as regards the terms infectious and contagious, which neither accords with general usage nor represents the established facts concerning the distinctive features and characteristics of these remarkable affections.

The word infectious (*inficio*, to stain,) is used in literature to express the idea of general contamination, as:

> "All seems infected that th' infected spy,
> As all looks yellow to the jaundiced eye."—POPE.
>
> "Infected be the air on which they ride."—SHAK.

It would seem not inappropriate to apply the term infectious to the whole class of diseases believed to be caused by the operation of a specific, aërial entity upon the system; and to restrict the term contagious (*contingo*, to touch one another,) to those diseases which are known to be transmissible, only, from one to another, by personal communication. Under so general a classification, the term *miasm* could be dispensed with entirely; while the word *contagium* might still represent a specific poison, and with a restrictive adjective, specify that of any individual disease. Our present use of the words *miasm*, *malaria*, etc., is arbitrary and indefinite in the extreme. Being terms of general signification to convey the idea of "bad air," they are also used to specify an individual type of fevers — those marked by periodicity. Surely the vocabulary of science is not so limited but that it might furnish a distinct name for so important a class of diseases, founded upon their special characteristics.

Under the two general divisions above mentioned, a particular disease might be, at once, infectious and contagious, as, for instance, scarlatina, variola, etc.; or it might be infectious and not contagious, as the malarious fevers, typhoid fever, etc.; or it might be contagious and not infectious, as syphilis, and all the diseases caused by the direct application of a special virus.

Such a classification, while expressive of all that we really know concerning causation, would place the expressions

more in accord with general usage, simplify the subject, and establish a definiteness of terms not now existing. Upon this basis, the author uses the words infectious and contagious, in this volume.

The terms *acute* and *chronic* infectious diseases, have herein, the meaning usual to them; as also those of *endemic, epidemic* and *pandemic;* which, relating rather to locality and extent, than to causation, need no other interpretation than those commonly given them.

The Geography of Disease.

That frightful disease, the cholera, has been subjected to the closest study in all of its aspects; one result of which, has been the development of a fact, more particularly to be dwelt upon hereafter, in relation to the whole class falling under scrutiny in these pages, viz: that this affection has a *locality* to which alone it is native. As must appear evident, this is an important factor in the problem of its precise causation. But with this exception, it may be said that sufficient attention has not been paid to the geography of the infectious diseases — the mapping out of localities of original and acquired occupation, and the regions of greater or less growth and prevalence, as well as the determining of climatic, physical and social conditions in particular connection with each. It is more especially this branch of the subject, to which the author proposes a contribution; one which may have some, or no value; but which is offered in the hope that it may prove an addition to the accumulation of facts, which must ultimately assist in working out these problems, if a definite solution is ever to be reached.

PART II.

PHYSICAL ASPECTS OF THE PACIFIC COAST OF SOUTH AMERICA.

CHAPTER I.

General Characteristics.

It may be said that the region above mentioned is, in many respects, one of the most interesting parts of the world, whether considered in its physical features or its curious medical relations, the latter having a large dependence upon the former. The writer has recently returned from a nearly four years' residence in the republic of Chile, and thereby enjoyed many opportunities for studying the whole coast from Panamá to the Straits of Magellan. Occupying an official position, also, his facilities for access to the men and institutions of the governments upon that coast were somewhat exceptional; and the collection of a large amount of valuable information, which he hopes to make fully accessible to those interested, has resulted therefrom.

In the consideration of the questions naturally involved in the lines of investigation herein pursued, the writer will be compelled to treat somewhat lengthily of the physical features of the South Pacific coast, and in a manner which to some may appear outside the strict limits of medical inquiry; but he expects to show, before concluding his remarks, that these features have an essential and inseparable connection, and go hand in hand with the medical

aspects of the region under study. Expecting hereafter to make a much more elaborate exposition of the remarkable phenomena herein imperfectly described, he will be as brief as is consistent with a proper understanding of the facts he wishes to disclose; although the thoughtful reader will, at once, realize the difficulty of compacting in a narrow compass, observations relating to a subject so large in proportions, and so extensive in the chain of circumstances which unites them together, and renders them of interest to the medical inquirer.

A voyage to the Pacific coast of South America is fraught with surprises to the medical man, as well as to the historian, the scientist and the general student. The civilizations there encountered are entirely different from our own, but they have many merits as well as demerits and peculiarities. It is here that a view is presented of the rapidly retreating customs, manners and life of nearly four hundred years ago—a view possessed of absorbing general interest. It is only so far, however, as the habits and modes of living affect health conditions, that the people can be studied from a purely medical standpoint. A coast line of nearly four thousand English miles, extending from the Isthmus of Panamá to the Straits of Magellan, including a range of latitude from the equator to 54 degrees south, would naturally imply a great diversity of climates, as affecting the people inhabiting this lengthened stretch of country. To the results naturally flowing from extreme range of latitude, there is added an element of potent and complex energy, in the existence of a chain of mountains, extending, with its lateral outliers, from Patagonia upon the south, to the upper part of Columbia, upon the north, the higher peaks of the main chain rearing their lofty heads far into the regions of eternal ice and snow.

The contrasts produced through this influence may be realized, by considering that the city of Guayaquil, in Ecuador, situated upon tidewater, not far below the equator, burns under the vertical sun of the tropics, and is only relieved by the cool nights of summer, when the *Chánduy*, a wind blowing over a contiguous mountain of that name, prevails; while in Quito, the capital of the same country, situated nearly upon the equator, but elevated only a little less than ten thousand feet above the sea, and lying at the base of Mt. Pichincha, whose altitude is nearly sixteen thousand feet, enjoys a delightfully temperate climate, often interspersed with snaps reminding one that he is but a few miles from where he may get a taste of genuine winter.

It is not alone with respect of thermal conditions, nor yet of those of atmospheric humidity, that this great work of nature is possessed of such strange influences upon the destinies of the people living under its shadow. Its other agency, which may be likened to that of an enormous battery, sending out and receiving flames of electricity, and playing currents of mysterious telegraphy between sea, and earth, and air, renders it of intense interest to the medical philosopher. There is a single word, which if uttered among the people of the greater part of the immense belt of territory under consideration, is one always of apprehension, and generally of wild fear and consternation—it is the word *terremoto* in the vernacular, and *earthquake* in plain English.

CHAPTER II.

Earthquakes From a Medical Standpoint.

In pursuance of our present objects, the medical man may pertinently ask, What causes an earthquake? The question has never been satisfactorily settled by physicists. The generally accepted theory of earth vibration, as a simple consequence of a volcanic eruption, or the impact of gases arising from an internal molten condition, creating trembling at a distant point, or a wave in the internal molten fluid, seems wholly untenable in view of the observations of the author upon these remarkable phenomena.

A very brief residence in the earthquake regions was sufficient to convince the writer of these pages of the direct connection between the manifestations of an earthquake and the sanitary condition immediately following it, such a belief being very general among the natives. The following extract from a communication by a prominent member of the Chilean *Protomedicato* to a statistical volume recently published,* will convey an idea of the expert opinion upon the subject: "Les tremblements de terre influent considérablement sur l'état sanitaire du pays; chaque secousse violente est suivie d'un grand nombre de maladies nerveuses, de fluxions de poitrine, de grippes, etc., et je connais un cas de folie survenu à Valparaiso à la suite des violentes secousses du 7 Juillet 1873."

With full belief in a relationship of far greater extent than generally supposed, the writer began a series of obser-

* "Le Chili, Tel Qu'il Est," par Edouard Sève.

vations upon the subject of earthquakes, and has a record of every important occurrence of the kind, with its attendant phenomena, for three successive years, embracing, in all, nearly three hundred shocks, of greater or less violence. Suspecting their causation to be in immediate connection with manifestations of the *electric* energy, he collected what seems to him abundant and overwhelming proof of the verity of this suspicion. Of the much interesting information obtained by his personal observation, that only need be given in this volume, which has an immediate or remote bearing upon the topic of the infectious diseases, ætiologically considered. And as a prelude to subsequent observations, some details of the conformation of the South American continent as influencing the questions of climate and health, must be briefly stated.

CHAPTER III.

The Andes.

This royal chain of mountains, containing within its length no less than fifty-one volcanic peaks, some of which are still in periodic activity, rises gradually in the southern part of Patagonia, and pursues a course nearly due north as far as about the 18th degree of south latitude, when it turns to the northwest in harmony with the configuration of that part of the continent; thus forming an obtuse angle with itself. Continuing its course to the northwest about as far as the 5th degree of south latitude, it reaches a point corresponding to the most western extremity of the continent, where it follows a course nearly due north through Ecuador, until the equator is reached. It then bends to the northeast through Columbia, in which latter state it gradually dips down, and is lost before reaching the river Atrato, near the 8th degree of north latitude.

The foregoing description outlines the general course of the Andes, and a reference to the map will show how curiously the chain is reared as a barrier facing the waters upon the east and north. This circumstance will be again referred to.

In Central America the chain again begins to rise, continuing through Mexico and the western part of our own country, until it once more shelves down to the river Mackenzie on the north. The South American Andes embrace a length of about four thousand English miles.

The line of perpetual snow throughout this great length

varies, of course, with the latitude and certain local conditions which influence it; but the main chain rises above the line pretty nearly from its origin, and so remains throughout a large part of its course. In the State of Columbia, however, there exists but one point above it. While these observations apply to the general line of the Andes, there are many, many peaks ranging in altitude from 12,000 to nearly 24,000 feet above the sea; awe-inspiring in appearance, and constituting the veritable and unapproachable thrones of the eternal Ice-King.

Influence upon Climate.

The proximity of a refrigerating element of the character above described would naturally be attended with remarkable influences upon the coast and valley climates below; but there are factors other than that of simple thermal change complicating our present inquiry; and to understand their force in relation to subsequent facts and conclusions, it will be necessary to recall certain other physical agencies.

For the purpose of convenient geographical reference, an outline map of the South American continent accompanies this volume.

CHAPTER IV.

The Trade Winds.

No estimate of climatic conditions, omitting a careful study of prevailing winds, could be possessed of any conclusive character. The climate which would obtain if the atmosphere were entirely motionless — that which Humboldt has called the *solar* climate — must be regarded as quite a different thing from *real* climate. These observations apply with peculiar force to the west coast of South America, as the author hopes to show before the conclusion of his remarks. .It will be requisite, therefore, briefly to consider the subject of winds, at this point. In doing so, however, it will simply be necessary to touch upon general principles, and make a local application only to the region under consideration. To attempt a complete statement of these important and complex agencies, with all their local modifications, would require an elaboration quite unnecessary to the purpose of the present volume.

The trade winds receive different names in different parts of the world. They are caused by the sun's heat and the revolution of the earth. The sun, by reason of the inclination of the earth's axis to the plane of the ecliptic, is vertical to a much more extended surface within the tropics than would otherwise be the case; thereby producing a certain degree of heat-compensation as between the points of relative proximity to the sun, arising from the greater convexity of the earth at the equator, and its decrease toward the poles. In consequence of these conditions the atmos-

phere of a considerable part of the tropics, though notably so about the equatorial belt, is heated to a much greater extent than elsewhere, and rising in obedience to the well-known law, the cold air flows in from the poles, thus creating two general currents — the one from the north pole, and the other from the south pole toward the equatorial region; the ascending current itself consisting of highly-heated air, with particles of moisture charged with latent heat.

Were it possible to conceive the earth as stationary, but heated in this equal manner at the tropical belt, these two currents would flow in straight lines, along the meridians, from the poles to the equator, and all levels of the earth below the line of congelation would receive a fixed quantum of annual rain, in accordance with latitude and some other modifying causes. As the earth, however, revolves upon its own axis from west to east, these two currents, in obedience to the laws of compound motion, are turned *obliquely* from the direct course; and hence it results that the north current blows from northeast to southwest, and the south current from southeast to northwest. In the equatorial region proper, a calm naturally exists by reason of the meeting of the two polar currents, as well as the friction of the earth and air. From this atmospheric stasis, rains occur in a certain belt north and south of the equator, to a large extent uninfluenced by points of mountain elevation.

The cold winds thus described as flowing from the poles to the tropics, are *surface* winds. The heated air of the equatorial belt, in rising to higher regions, has acquired a certain momentum from west to east imparted by the earth's rotation, and hence, these upper currents — called the *anti-trades* — flow off toward the poles in an oblique

direction, the current in the northern hemisphere becoming a *southwest* wind, and that in the southern hemisphere a *northwest* wind. During the winter months of the southern hemisphere, when the latter current comes to the surface much sooner than during the summer, the South Pacific coast is frequently visited by "northers," which are more destructive of shipping than any wind of that quarter of the globe.

These lower and upper currents of cold and heated air are considered constant currents, and within particular restrictions, induced by a variety of modifying agencies, they undoubtedly are so. But the limits within which these winds play are circumscribed by the upper current of heated air gradually becoming cooled in its flight, until it falls to the surface, when it returns as a lower current, from the poles to the equator. Now, these limits are arbitrarily fixed at about the 25th or 28th degree, north and south; but the real fact is, that they constantly vary with the seasons — advancing to the north when the sun brings summer to the northern hemisphere, and to the south when summer visits the opposite hemisphere. Hence, in the latter part of the world, the limit of the southeast trade is generally admitted to be as high as the 30th degree of south latitude; but the writer's observations lead him to believe it to be considerably higher than that.

The foregoing description of the trade winds corresponds, in the main, with the generally accepted theory, and was first advanced by Halley, the English philosopher. It is proper to mention, however, that of late years, its correctness has been disputed by some eminent authorities, as Dove, Wilkes and Blodget. Capt. Chas. Wilkes* rejects

* "Theory of the Winds," etc.

the purely calorific theory, and believes all winds in the middle latitudes to be caused by the unequal distribution of land surface and of heat.

Blodget* substantially adopts the same view, and adduces the observations at different stations in the United States, which all go to show that in the middle latitudes of the temperate zone, a strong and uniform *westerly* movement constantly pertains; and that the belt which contains the westerly winds, is marked by constant or equally distributed rains.

Every one, whether professional or non-professional, accustomed to observe the weather movements in our country, cannot have failed to notice the general prevalence of this *west* wind, spoken of by Blodget, and its accompanying rains. But a movement of air across a body of land, subject to thermal effects of a kind differing from those of water, and interspersed with elevations and depressions of surface complicating simple motion, must be attended as one would think, with very contrary results from those produced by the passage of air over the relatively plane surface of a body of water.

The whole subject of winds, even within the latitudes assigned to the trades, is a very complicated one, and surrounded with contradictions of a most perplexing character. When the higher latitudes are reached, as, let us say, from the 25th or 28th parallels to the polar regions, each observer is left to form his own opinions; there being no well defined laws governing, or even general agreement as to the special causes and particular directions of, the winds. A portion of this latter region falls under consideration in these pages; and its sanitary, as well as economic and other characteristics, are affected in a very important manner by the direc-

* "Climatology of the United States."

tion of the winds, representing the distribution of rain, as will be illustrated further on.

Why the Subject of Winds is Important.

What may be the particular causes operating to produce the trade winds over the great oceans, and a *western* wind over the middle belt of the North American continent, the latter constituting the rain-wind for that region, need not, for our present purposes, be further inquired into at this time. The writer believes it to be an indisputable fact, that there exists *no* regular belt of western winds, bringing constant or equally distributed rains to the north Pacific coast; and he is quite certain there exists none bringing such rains to the south Pacific coast; *except* in both instances, where such rains are made possible *through circumstances of land configuration.* He believes from his own observations, that the southeast trade wind *does* operate within the limits stated, and in the manner described; and is *de facto* the great rain wind, if it may so be called, for the whole region bounded by its southern extension. This fact is fraught with the most momentous consequences to all those people, who live *under the lee* of the great mountain chain of the North and South American continents.

On the North American continent, and to the east of the great mountain chain extending, under various names, from Patagonia far into British America, there exists no elevation sufficiently great to bar off completely the otherwise natural distribution of rain and its accompanying results. The northeast trade blows uninterruptedly and carries its blessings over an extensive region. The southeast trade, which should carry the eastern clouds with which to fructify the whole South American continent, is met by an icy barrier, arresting the clouds in their flight, robbing them of

every drop of moisture and creating districts to the west of the great chain, rainless during the whole or a portion of each year. Hence, the greater part of the south Pacific coast never receives any rain whatever from the eastern clouds; and a part of it, none from any source, except, possibly, as a rare phenomenon long to be talked of among the people.

Where the Rains Come From.

Physicists are agreed, that the land of our globe is heated by the sun with much greater intensity than the water of the oceans. This is considered due to the fact, that the solar heat does not penetrate below the earth's surface to so great an extent, as it does below the surface of the water. While penetrating one inch into the earth, it penetrates water to the depth of many feet; and it has been estimated that the sun's rays impart *one hundred times* more heat to a given surface of ground in one day, than to an equal surface of water during an equal time. If this be true, and there can be little doubt of it, except as to degree, perhaps, it is an easy matter to understand the influence exercised by large bodies of land, in the production of local wind currents. The heated earth heats the stratum of air immediately resting upon it; the latter rises, and an *aspiratory* effect ensues, by which the cooler air of the adjacent ocean flows in to occupy the space left vacant by the rarefied air.

As the result of careful study, the writer is convinced that this is the simple principle underlying the production of winds above the limits of the trades, modified as to force, amount and direction by various circumstances not necessary to enumerate here in detail. Between the lowest spurs of the Andes in Patagonia and the rise of the mountains again in Terra del Fuego, a southeast wind

from the Atlantic prevails; but in accordance with the simple principle above stated, there is a general current of air from the south polar regions toward the southern continent, producing a conflict of "contrary winds" about its extremity at Cape Horn, which any one who has "doubled" the latter in a sailing ship will have good cause to remember. The general rush, however, is from the polar regions, as also to a less extent, from the ocean waters on the west.

At the equator, or point of greatest convexity of the earth, the velocity of axial rotation is about nineteen miles per second. This velocity, of course, decreases in a certain gradation toward the poles; so that in the high latitudes herein spoken of, the earth has not a rotary velocity sufficient of itself to produce wind currents; hence, it results that the wind currents flow along the south Pacific coast, almost in the line of the meridians, or at furthest, from a point to the southwest. It is a common observation in Chile, that "the rains come from the south," and the foregoing is believed by the writer to be its proper explanation. In speaking of the rain clouds within the limits soon to be defined, they will be designated as the "polar clouds," under the above interpretation.

Now in accordance with this origin of rain from the southern regions, it is found that the northern limit of the rain line along the coast bears a constant relation to the seasons; or in other words, to the position of the sun. The southern part of the continent, up to a certain point, enjoys a regular rainfall throughout the year, from which point there is a regular decrease of the annual fall of rain until a point is reached in Bolivia extending through a great part of Perú, where rain *never* falls (except as previously stated), being that region barred of its rain from the Atlantic clouds by the great mountain chain on the

east, and prevented from receiving any from the south by the sun, which causes its precipitation in the higher latitudes. During our winter in the northern hemisphere, the sun is south of the equator, and in his southern advance cuts short the rainy season in the localities successively subjected to his immediate influence, by causing rain precipitation in the advancing clouds. The local dew point is thus constantly receding before the solar advance. When the sun again goes north, the rain line follows him to its utmost limit, and winter and the rainy season go hand-in-hand. It results from this, as a matter of course, that different districts vary in the number of months of annual rain which each enjoys. In the latitude of Santiago, Chile, where the author was resident, the rainy season only lasts about four months, while in the far southern part of Chile, it lasts throughout the year.

This short description of the subjects of wind and rain, if carefully considered, will enable us to take another step in the investigation of the highly interesting field before us.

CHAPTER V.

The Earthquake Under Medical Scrutiny.

We are now in better position to approach the consideration of the remarkable phenomena denominated *earthquakes*. But what, it may be asked, have these to do with the medical man, or the subject of infectious diseases? It is one of the main objects of these pages to consider that question.

Every one knows that the generally accepted theories of earthquakes rest upon the assumption of an internal molten condition of our globe, through which gases are generated, producing tension and vibration of the earth's crust, either through waves or distant impact. Whether or not this internal molten condition exists, we need not here inquire. So far as the theories themselves are concerned, the author is bound to believe, in view of his own observations, that they are entirely fallacious. To go fully into the details of such a question would carry our special inquiry away from its purely medical character, far into the arena of the physical sciences. It is a subject, however, which may be of interest from a medical standpoint; and while the author cannot hope that any opinion of his own, here expressed, will be taken as a thing *probatum est*, yet as he may, with propriety, adduce a few general arguments in support of what he has to say, he expects to show a reasonable basis, at least, for his conclusions.

An earthquake, then, does not represent a mere vibration of the earth in consequence of percussion or impact

at a distant point, but is *directly caused by the actual transmission of a certain form of energy, from point to point covering the manifestation of the attendant phenomena.*

As will be observed, this form of energy is not here expressly designated as the *electric,* though it seems impossible to imagine it as any other. Without doubt, every known form of force or energy *proceeds from a single essence* — the force unit, so to speak, of nature. While it is not impossible that the earthquake energy is a special transmutation of that force, it is not at all probable that it is so; indeed, every observed effect leads the author to believe it identical with electricity, and he has been accustomed to speak of it familiarly as *terrestrial lightning.* In making such a statement, he is aware that he places himself entirely in opposition to all received opinions; but his convictions are the result of personal experience and study, and should, upon that account, be entitled to a fair consideration.

The occurrence of a pronounced earthquake is usually preceded, attended with, and followed by, a number of very singular phenomena.

The *antecedent* events are generally of a *meteorological* character, and closely connected with conditions of atmospheric electricity, as we are commonly acquainted with them. So constantly is this the case, that it is quite possible to state the time of the probable earthquake occurrence, weeks in advance, and with nearly the same certainty that the "probabilities" office at Washington maps out the weather changes. In the instance of the terrific earthquake at Riobamba in 1794, a prodigious number of shooting stars were seen at Quito before the shock occurred; and Humboldt tells us that on a certain night preceding a shock, the

mountain Cayambe appeared surrounded with meteorites for an entire hour.

So emphatic and pronounced is the atmospheric alteration immediately preceding a shock, that the people of earthquake countries have learned to recognize "earthquake weather"; and the author is personally acquainted with reliable people in South America, who are able to predict some minutes in advance, that a shock is coming. One of these, a foreign minister, resident at Santiago, is awakened if asleep, a few minutes before a shock, and by those which are not preceded by a noise, as well as by those that are. Another case is that of a lady in the same city, who is generally able to predict violent shocks, for a considerable period in advance of their occurrence, by peculiar sensations which she claims to experience in her feet. In some regions of violent action, and notably in some peculiar localities in Bolivia, the hair of an animal, or the fur of a cap worn by a man, will become erected in connection with earthquake conditions. Many interesting and authentic facts of a like character could be given.

The phenomena which *attend* the actual occurrence are many and instructive, and were the subject of observation and experiment by the author, who experienced a large number of earthquakes while in South America.

The magnetic needle, when the observation is possible, always shows, during an earthquake, a disturbance, or deflection from the magnetic meridian of the spot where it is located. The writer had an improvised needle swung with a very delicate arrangement, which rendered it, to a sufficient extent, self-marking in its movements. It very constantly showed a disturbance to have occurred during every severe shock: which disturbance was, manifestly, always of a defined and methodical character, and not connected simply with a shaking of the instrument.

Quite recently, a corroboratory observation has been made by Mons. Lamont, Director of the Observatory at Munich, who states that by chance he saw the declination needle receive a sudden jerk, the oscillation continuing for some time. After several days, he received news that violent oscillations of the needle had been observed at Parma, and subsequent computations showed that the movement had begun at the same moment in Parma and Munich; while later still, reports were received of a violent earthquake occurring simultaneously in Greece.

The phenomena *following* an earthquake of any severity are also very interesting. If the sky be *clear* before the shock, it usually becomes clouded at once, or very soon after, and a fall of rain is apt to occur; but if the sky be already *clouded*, the fall of rain is generally precipitated in a very short time; and it is not only a curious, but likewise an instructive fact, that if the rainfall be copious or prolonged, the danger of immediately-recurring shocks is over.

One of the most remarkable effects of an earthquake of any special force, an interesting one to the medical man, is the free generation in the air of a principle, which responds to all the tests of the body called *ozone*. The experiments made in determination of this point were various, and continued through a period of three years.

CHAPTER VI.

Concerning Ozone.

Let us leave, temporarily, the subject under immediate consideration, and give present attention to this mysterious body, so illy understood, even in our own day.

Ozone is a peculiar something, better known by what it does than by what it really is. The occasional presence of an unusual ingredient in the atmosphere has probably been realized by its simple odor ever since the advent of an air-breathing animal upon our earth. The writer was on board a vessel at Colon, when the mainmast was struck and shivered by a bolt of lightning. He was also once upon a train of cars suddenly thrown from the track while at a high rate of speed. The intense sulphurous smell was as remarkable when caused by the grinding and friction of iron wheels and rails, as when evolved by the electrical stroke. Homer distinctly speaks of the sulphurous smell of a thunderbolt, in the *Odyssey* as well as in the *Iliad;* and, doubtless, the personal experience of many of the author's readers has rendered it familiar to them.

The discovery of ozone followed as a consequent of the discovery of oxygen in 1774. In experimenting with the "vital air," Van Marum, of Holland, about the year 1785, passed electric sparks through a jar of oxygen, and found that a peculiar smell was produced, while the gas had acquired a new power — that of acting directly upon mercury. In 1839, Schönbein, the Professor of Chemistry at Basle, discovered the same smell while experimenting upon

the decomposition of water by Voltaic electricity. From this time to our own, the new principle has been investigated by thousands of earnest inquirers, but although its existence has been recognized, and its effects well observed, its ultimate composition is still subject-matter of doubt with many. Our new chemistry fixes the formula of oxygen as O_2, and ozone as consisting of an additional atom, would be represented by the formula O_3, or O_2O, its formation being dependent upon the condensation of oxygen into two-thirds its former volume. If this statement be correct, the oxidizing power of ozone consists in the facility with which each molecule loses its third atom; and hence it is simply oxygen in an *allotropic* condition.

Following the settled existence of a body called ozone, came the discovery that it was an oxidizing agent of great energy, and the most powerful disinfectant known, in its concentrated state exceeding in bleaching properties even chlorine; which latter, it may be claimed, can only exert its peculiar properties in presence of, or in connection with, a certain proportion of oxygen.

Then came a knowledge of the constant existence of the ozone principle, in greater or less proportions, in the atmosphere; and that the "purifying" effects of a thunder-storm were due, not alone to the washing out of the air, but to the destruction of the impurities themselves by the development of ozone, through electrical action. And further than this, ozone was found to be produced incessantly by agencies less violent than thunder-storms, which evolve electricity continuously. Faraday discovered that the friction of water drops against air developed negative electricity; and Humboldt, that a waterfall or lofty cascade fills the surrounding air with negative electricity. Hence the fall of rain, dew, hail or snow produces it, as do the friction of atmospheric

currents, the dash of sea waves upon each other and upon the rocks and shore, and the thermal changes brought about by evaporation from rivers, lakes and seas.

Further still, ozone is now claimed to be developed in the air by plants, trees and nearly all kinds of vegetation, and hence has come the recommendation to plant sunflowers and other varieties of odoriferous flora, as a protection against "malaria," which latter ozone is supposed to destroy; and recently the Australian gum-tree has been extensively cultivated for this purpose.

Following these developments came the suggestion that the sanitary state of communities was directly influenced by the plus or minus quantity of existing ozone. Schönbein himself was firmly of the opinion that epidemic diseases had an existence inversely in proportion to the quantity of free ozone in the atmosphere, and cited in proof the assumed fact of zymotic diseases being least prevalent in winter, when the amount of ozone is greatest. These views were held by many others whose opinions were entitled to respect, and experimentalists in all parts of the scientific world began observations, with the view of noting the connection between prevalent diseases and the amount of existing atmospheric ozone.

Many of these were made in connection with cholera visitations, and were upon a very extended scale, as those of Glaisher, Moffatt and Hunt, of England; Cook, of Bombay; Smallwood, of Canada; Fournet, of Lyons; Peter, of Lexington; Seitz, of Munich; Denza, of Turin; Robert, of Neudorf; Simonin, of Nancy; Strambio, of Milan; Wolf, of Berne; and many others. Apparently systematic observations have also been made to determine the relationships between the amount of existent ozone and such affections as catarrh, influenza, pulmonary consumption, and diseases

of the respiratory tract in general; typhus and typhoid fever; rheumatism; malarial fevers; diphtheria; small-pox; scarlatina; the cattle plague; and descending to the vegetable world, the "potato" and "grape" diseases.

Most unfortunately, the reported results of all these observations are so very conflicting as to furnish no data upon which to erect any certain lights which may go to illuminate the dark corridors of disease-causation. So far as cholera is concerned, perhaps, the weight of evidence is favorable to the antidotal and preventive properties of ozone. In general, however, it may be said that no definite and specific laws have been discovered governing the effects of this remarkable body in health and disease; though when it is remembered what an extensive field exists in the attempt to study our atmosphere, involving as it does a knowledge of chemistry, meteorology and other of the physical sciences, but above all, the imperfect and precarious tests for ozone, as yet in our possession, it is hardly to be wondered at that the results thus far obtained are so contradictory and widely divergent.

Tests for Ozone.

The writer gives below the tests for atmospheric ozone:

1. Potassium Iodide.
2. Red Litmus and Potassium Iodide.
3. Pure Silver.
4. Copper and Acetic Acid.
5. Potassium Iodide and Starch.
6. Thallic Oxide.
7. Manganous Sulphate.
8. Lead Sulphide.
9. Resin of Guaiacum.
10. Indigo.
11. Certain Fungi.

Very few of the above are at all reliable as tests for ozone, since other purifying principles exist in the air, as the peroxide of hydrogen (called by some *antozone*, and by Frankland *hydroxyl*), and the acid compounds of nitrogen and sulphur; any of the last named being capable of acting upon different tests, and thus destroying their value. The popular test in use consists of a slip of paper which has been dipped in a solution of potassium iodide and starch—it being known that ozone in decomposing the iodide and setting free the iodine, allows the latter to unite with the starch, whereby a blue color is struck upon the paper. The value of this test is entirely destroyed, however, by the fact of the atmospheric disinfectants above named producing the same effect. In the use of any ozonoscope whatever, it is essential that it be protected from currents of air; that the temperature should constitute part of the observation, and that light itself should be excluded, these conditions requiring an apparatus in the shape of a box, with an attachment whereby exposure of a given surface only may take place in a given time. These considerations, coupled with the circumstance of the impurity of many articles of commercial drugs, and even foods (much of the potassium iodide of the shops being adulterated with the carbonates, sulphates and chlorides of potash, soda and lime; and the starch by sulphuric acid, lime and salts of chlorine), render the reliability of general observations upon ozone very questionable indeed.

When it is remembered that many recorded observations relating to the connection between the amount of existent ozone and various diseases, as cause and effect, have for a basis the simple flying of a bit of starch-paper out of a window, their worth may be judged in the light of the foregoing statements; and there need be no surprise that many

eminent scientists and medical men have ignored the whole subject; nor that Prof. Henry, of the Smithsonian, should have declared that "there were no trustworthy observations on ozone made in the United States"; nor that a committee of the council of Scottish Meteorological Society should have reported in 1869, that "no method has yet been devised by which it can be ascertained that ozone, and *ozone alone*, is the coloring agent"; nor that a French savant, Mons. Cloez, concludes that ozonometric observations are destitute of value — "*n'ont aucune espèce de valeur.*"

The writer in his South American observations used three or four different tests as corrective of each other, but relied chiefly upon the *iodized litmus* of the French observers, as being, in his judgment, altogether the most trustworthy and free from objection; and believing, with Fox, that it is practically uninfluenced by any other known constituent of the air. For the information of those who do not know its mode of preparation, it may be stated that it can be made by simply dipping red litmus paper into a dilute solution of potassium iodide. Under the influence of ozone, the iodide is decomposed, and the potassium being oxidized to form the free alkali potassa, the litmus assumes the usual blue color, varying in intensity according to the existent amount of alkali, the latter depending, of course, upon the amount of the oxidizing agent.

General Properties of Ozone.

Some of the observations which have heretofore been made upon this subject, as well as some which are still to follow under this head, as considered in their bearing and points of application — if any they have — would more appropriately fall under the third part of this little volume, which latter aims to be of a purely medical character, if

such an expression be permissible. The writer, however, desires to preserve the continuity of each subject discussed, so far as possible; and therefore proceeds with his further remarks upon ozone and its collateral questions of interest.

Ozone is the most powerful disinfectant and purifier known, destroying atmospheric contaminations upon a large scale, which, but for this agent, would be fatal to human life. The details of an experiment, whereby the putrified blood of an ox, exhaling most offensive gases, was rendered entirely sweet, and regained the power of coagulation, by passing over it a stream of ozone, are probably well known to all.

The relative diminution or apparent entire absence of free ozone, as regards the air of all great cities, as well as many smaller ones, results from the necessarily large demands made for the disinfection of impurities generated by the aggregation of people in confined districts, and environed with all the refuse of manufactories, as well as of the industries and personal necessities of daily life. Hence the expediency of the very general custom which avoids the construction of hospitals in thickly-settled portions of a city, or in the vicinity of noxious or odorous emanations.

Its Effect upon Man and Animals.

Ozone in sufficient concentration would be destructive of the lives of man and animals alike. They could no more live in pure ozone than in pure oxygen; hence the necessity of proper dilution. With an amount not exceeding the normal maximum, a general invigoration of all the functions is experienced; and in such an atmosphere, it may be asserted that, other things being equal (the exception to be noted hereafter), the greatest human longevity is attained. In this connection may be cited the robustness

of mountaineers in general, and of dwellers near certain seacoasts and in or near pine forests, in all of which localities the elimination of ozone is in constant activity.

Its effect upon animals is similar to that upon man, but it would appear that the susceptibility of different species varies, and the toxic amounts have as yet no determined relationships. The effects are said to be more pronounced upon rats, for example, than upon guinea-pigs; and upon the latter than upon rabbits. Air containing the one six-thousandth part of ozone, destroys mice immediately. Birds in general bear a large percentage of ozone, because of their life in the upper air; and it is here interesting to note, that the South American Condor (the *Sarcoramphus Gryphus*), inhabiting the highest passes of the Andes from 12,000 to 15,000 feet above the sea, and able to soar to a perpendicular height of *six miles* above its level,* and therefore a bird of immense power and development, attains to great longevity. The writer brought home a specimen for the Yale College museum, which must have been a very patriarch in his solitudes of snow and ice.

Its Effect upon Insects and Aërial Organisms.

Some interesting experiments were made by the writer, to determine the effect of ozone upon small insect life, many varieties of which were placed under bell-glasses, so arranged that the silent electric spark might be passed through the contained air, and a fixed amount of ozone generated thereby. Death uniformly resulted, sooner or later, in accordance with the percentage of ozone to the quantum of air.

As to the destructive effect of ozone upon aërial organisms, whether of an animal or vegetable character, we have some presumptive evidence, strengthened by the results of

* Gilliss' U. S. Naval Astronomical Expedition to the Southern Hemisphere.

observation and experiment. The purifying effects of a thunder-storm are well known to all, and the frequent, if not constant mitigation of a prevalent epidemic influence, even though temporary, after sharp electrical manifestations, must be especially familiar to every observant medical man.

Mr. Lea, of Philadelphia, has published a paper in Silliman's Journal (vol. xxxvii, 2d series, 1864) on "The Influence of Ozone and Some Other Chemical Agents on Germination and Vegetation," of a highly interesting character. He has shown that the growth and vigor of plants is retarded and impaired in air strongly impregnated with ozone, simple vegetable structures, as mould, being completely destroyed under such an influence.

Other experiments have been performed, also, which go to show, that ozone has some power, at least, to destroy the invisible entity constituting the producing cause of malarious or periodic diseases. The word entity is here used, because the proof of such causation regarding the above named class of diseases is conclusive, whatever doubt may still exist as to the real *materies morbi* of the general infectious diseases. The mechanical protection afforded by a curtain of moistened canvas hung between the sources of the malarial influence and the adjacent dwelling, is well established, and admits of no other interpretation.

It must be admitted, however, that up to this time, experiment has failed to establish fixed axioms regarding the precise relationships of ozone not only toward parasitic life in general, but, also, toward that remarkable class of diseases, capable of suddenly invading the citadel of health by unseen enemies and through unknown portals, and with giant hands, laying it in ruins. The whole subject is one of immense difficulty, as involving forces and agencies of nature with which we are but little acquainted, and with

whose etherial existence we have but few channels of communication.

Conclusion as to Ozone.

But the author has stated the free elimination of ozone to be one of the consequences of earthquake action. That this is a fact, he believes as the result of his own observations, as well as from many strongly corroboratory circumstances, one of which he desires to mention in conclusion of the subject. One Mons. de la Torre has recorded his experiences of an earthquake in one of the copper mines of Cuba, which converted the town of Santiago on that island into a heap of ruins, November 1, 1852.* The chief occurrences of note, were the fearful and extraordinary noise; the rising and falling of the ground, and the filling of the mine with such an intense *smell of sulphur*, that had the narrator possessed any experience with the body called *ozone*, he must have recognized its presence, at once.

Before closing these remarks upon the properties of ozone, the writer desires to acknowledge his indebtedness to Dr. Fox, of Edinburgh, for many of the facts herein given concerning a body possessed of such profound interest to the medical man.†

Antozone.

It is quite probable that this principle is very constantly developed under the same conditions which operate to generate ozone. The author made no experiments to test the question. Antozone is said to be the peroxide of hydrogen, and by many is supposed simply to represent oxygen in that indefinite, hypothetical state expressed by the word *positive;* while ozone itself exists in the opposite or *negative* state — two terms, however, destined ere long to be entirely banished from the nomenclature of science.

* "Volcanoes and Earthquakes." By MM. Zurcher and Margallé. London. 1874.

† "Ozone and antozone." By C. B. Fox.

CHAPTER VII.

Further Consideration of the Earthquake.

After this somewhat lengthy digression, the author desires to return to the subject of earthquakes for a short time. He has heretofore stated some propositions concerning the cause of earthquakes and their attendant phenomena, which, doubtless, will be considered novel by all, and fallacious by many. If they be true, however, they have an importance, in a medical sense, difficult of overestimation. Certain additional facts concerning the phenomena of earthquakes and the induction of peculiar atmospheric states, have been reserved to this point, that the various coöperating agencies might be considered together, and gradually brought to such convergence as to render their combined effects easy of consideration.

Certain mention of electrical disturbances in the atmosphere, preceding the shock of an earthquake, has already been made; and it must be understood that reference is always had to those of some violence, and not to the simple tremors, so often experienced in earthquake regions. The Spanish Americans have two names for these occurrences, according to their degree of violence — *los temblores*, the slight; and *los terremotos*, the strong and destructive.

The electrical accompaniments spoken of are constant, and have been noted in all ages and in all localities of which we have definite record. In the case of the city of Lisbon, where 30,000 people perished in a few minutes, as the result of an earthquake, the preceding electrical phe-

nomena have been graphically described; as also a well-established fact of strong correlative importance, viz: that Mount Vesuvius, which was in full eruption at the time, *became quiet* at the moment of the shock.

Some beautiful electrical displays have been witnessed by the writer in South America, two of which he may be excused for specifically mentioning. Upon the occasion of a pleasant night, there appeared in the sky a long narrow ridge of cloud, stretching from the clouds of Magellan on the west toward the land on the east. Otherwise the sky was clear, and presented the marvelous appearance of transparent atmosphere, through which every star in the heavens appears as brilliant as a diamond, but which so often presages a coming shock. Suddenly the *aurora australis* lit up the southern sky, from the pole to the cloud above mentioned, glimmering like the soft sheen of a midsummer's moon. "We shall have a shake before morning," said a friend to the writer, while looking at the beautiful phenomenon. Scarcely was the sentence completed when it came like a rush of lost spirits, clanking their chains in the wildness of despair.

Upon another occasion, the writer was enjoying a balmy evening in the plaza at Valparaiso. The night, though soft and pleasant, was dark, there being no moon, and the sky clouded. Suddenly the whole city was illuminated with a brilliant light from the clouds above, which latter resembled the phosphorescent ocean. In a few seconds the light was gone, but in its wake came the *temblor*. The next day it was learned from the interior that a meteor, of surpassing brightness and size, had passed over the sky from southwest to northeast, in advance of the shock. The appearance of meteors in Chile, during the earthquake season, is so common as to excite but little comment.

Another electrical manifestation, however, of far more importance, is the occurrence of "summer lightning" upon the tops and to the east of the Andes. This is almost of nightly occurrence during the summer, or *dry* season. As often seen by the author in his travels, it appeared as though the elements were waging battle together; or that the demons of the mountains, like Rip Van Winkle's ghostly community, were bowling mammoth ten-pin balls among the lofty granite peaks.

Earthquakes and Thunder-storms.

While these manifestations of electrical action exist in connection with the earthquake regions of South America, there is another very curious, very interesting and very instructive circumstance, consisting of this: that in the earthquake districts proper there are *never* any storms of rain with thunder and lightning, except to a limited distance upon either side of the equator, occurring through natural causes and irrespective of questions of land elevation. The writer uses the word *never*, though it is not strictly correct; but such things are so very exceptional as to render the statement quite the rule. He was a witness to one storm of thunder and lightning in Santiago, which seemed to terrify the people more than a half-dozen *temblores* would have done, although he endeavored to convince his friends that it would bring a respite from earthquakes, for a time at least, as it certainly did.

And here the author will state, what he believes to be a law governing earthquakes, viz: in regions of country situated away from the immediate influence of volcanic action; out of the line of transit between two elevated ranges, or an elevated range upon the windward side and an ocean upon the lee; in regions receiving a proportionate or regularly

distributed annual rainfall, *earthquakes cannot exist* except as erratic phenomena.

Let those who have any experience in the affected regions, under consideration in this volume, recall the very significant fact, that when the immediate influence of the great magnetic chain of the Andes is escaped, no earthquakes occur to the *east* of them. Mendoza, situated upon the eastern base of the Andes, was destroyed by an earthquake in 1866; but the town was built upon or near the base of the mountains. Except as an erratic occurrence, like similar ones in non-earthquake parts of the world, and easily explainable upon the general principles herein laid down, no one ever heard of an earthquake on the great pampas of the Argentine Republic, or on the South American Atlantic coast, where there exists a regular fall of rain from the clouds of the southeast trade, and sufficiently away from infected mountain districts to escape their influence.

Upon the contrary, it is susceptible of direct proof, that the earthquake propensity upon the west coast of Chile is inversely to the annual rainfall. In the regions of northern Chile, where there is a minimum rainfall, the shocks are frequent and terrific; in central Chile, where about a four months' rainfall is enjoyed, they are less frequent and less severe; in southern Chile, below Valdivia, where there is much more rain, the shocks are slight as a rule, and infrequent; while in southern Patagonia and about Punta Arenas, in the Straits of Magellan, where there is an approach to a regularly-distributed annual rainfall, they are said to be an unknown phenomenon. An occasional infliction, however, might easily occur in view of the proximity of the neighboring peaks of Terra del Fuego.

From the foregoing observations, it may be correctly inferred, that the author of these pages entertains this

belief: that if all the mountains of the world were leveled down to a height permitting of an unobstructed and regular annual rainfall in its various parts, while we should have frequent storms, with pretty brilliant, startling and sometimes destructive, electrical manifestations, the earthquake would be an impossible phenomenon. Hence, the writer, when frequently asked in South America, if, in his belief, earthquakes were preventable, he invariably replied, that they could be pretty effectually prevented,— *by leveling down the Andes*, so that there would be no altitude above, or near, the snow-line.

CHAPTER VIII.

A Review of the Position.

The author's record book teems with collected facts relating to the subjects herein treated, all of which he hopes to put in a more systematic shape in a special treatise. His present object being a double one, that of studying a particular region of the world, in both its physical and medical aspects, the one must be subordinated, to some extent, to the other.

Let us look behind us for a few moments, in order to discover where we stand. We have learned that the South American continent is traversed near its western border, by a lofty mountain range; that this range runs, practically, from south to north as far as the 18th degree of south latitude, thus presenting a broad front to the south Atlantic sea-board; that from this point it trends off to the northwest as far as the 5th degree, when it turns to the northeast, and is lost before reaching the Isthmus of Panamá, thus rearing a defiant front to the waters of the tropics on the north and east. We have seen that the clouds brought over by the southeast trade, which should irrigate the west coast of the continent, are arrested in their flight by the ice-peaks of the Andes, and robbed of their moisture; and that in consequence of this, the portion of that coast south of the 5th degree gets whatever rain it receives from another source, principally, if not solely, from the clouds of the south polar region, except at the southern part of the continent, where the mountain chain shelves down to an

extent permitting, probably, some rainfall from the east. We have seen that earthquakes are frequent throughout the region, which is rainless, in whole or in part; that electrical manifestations are very constant as associated events; and lastly, that the body answering to the tests for ozone, while not always markedly present in the atmosphere, becomes exceedingly abundant after a decided earthquake.

Interpretation of the Facts.

What is the logical interpretation of this chain of facts? Simply this: that there follows, as a consequence of the physical construction herein dwelt upon, an interruption of that energic equilibrium of this region, which otherwise would be brought about through the medium of thunderstorms; and that earthquakes, with all their accompanying horrors, result from nature's efforts to restore that equilibrium. The rain clouds of a certain part of the world are brought by the prevailing winds against an elevated barrier covered with ice, and are at once arrested in their flight, and completely robbed of their moisture through condensation; the electricity which they have collected by heat and friction in their passage, and which is evolved by the change of water from a vaporous to a liquid form, is discharged into the earth. This fact is beautifully illustrated in the latitude of Santiago de Chile during the summer months. The sun then being far south of the equator, the rain line of the south polar clouds is driven to the extreme southern part of the continent, while the Atlantic clouds are caught and held by the tops of the Andes. During the whole summer of eight months' duration in this latitude, the play and interchange of lightning can be seen going on in those mountain fastnesses; and as the earth at those points becomes excessively charged, the surplus

energy is transferred, in a quiet manner by direct conduction, to the waters of the adjoining ocean. During this whole time an enormous accumulation of the particular form of energy denominated electricity, must be taking place in those portions of the earth. The magnetic pole of the southern hemisphere has not yet been satisfactorily determined. It may or may not have a relationship to the earthquake region.

As the seasons revolve, the sun again goes north, and the southern latitudes experience winter. As the earth cools, the south polar rain clouds advance to the north, until they meet a temperature sufficiently high to precipitate their moisture in the form of rain; thus establishing the rainy season, which varies in duration for each locality, of course, in relation to its latitude and actual temperature. It is during the season when these clouds prevail, i. e., the *winter* season, that earthquakes predominate, the rationale being thus: the earth and adjacent ocean have been highly charged with the electric energy during the previous summer; when the great nebulous mass approaches from the south, overspreading the whole southern sky, and nears an elevated peak, an attempt at equilibrious restoration occurs, this having been previously prevented by the circumstance of dry air itself being a non-conductor. When the approach is sufficiently close, the discharge takes place, with terrific effect, as not a single cloud, but a great sea of clouds, is implicated. It thus results that the effects are upon so large a scale, the electric energy rushing, so to speak, from all the supercharged territory to participate in the equilibrious attempt, including that portion stored in the adjacent waters.

The fact of a participation in the earthquake action by the neighboring ocean, whatever may be the explanation of

that action, is a well established truth. Darwin* dwells upon this accompanying agitation of the sea, as observed while on his voyage in the Beagle — as have other writers. The author has frequently noticed, that after a shock of any severity, affecting the city of Valparaiso, in Chile, the water in the bay, although very deep, and never yet affected by the dread "tidal wave," is invariably *discolored.*

Upon the foregoing explanation of these remarkable phenomena, which the author believes to be the correct one — so far, at least, as the general principle involved is concerned, it is quite easy to understand many very obscure things in connection with them. As, for instance, why rain always falls over some portion of the affected district, after a shock; and why, when once the fall begins, the assurance is popularly felt, that so long as it continues, there is no further danger of any severe manifestation. In the first case, the electrical action produces that change of temperature, necessary to cause precipitation from the clouds; and in the second case, each little stream of rain acts as a conducting wire between the earth and clouds, insuring against further violent action, so long as the communication is thus maintained.

During nearly three hundred shocks of earthquake, which the author experienced or recorded, while in South America, two thirds of that number were attended with a clouded sky at the point of observation; and of those not so attended, ample evidence of the existence of such a state, in a locality sufficiently near to connect one with the other, was always obtained. Hence, the well known fact, that however clear the sky when a violent shock occurs, rain generally follows soon after, over the whole district affected by it; and as the author believes,

* "Naturalist's Voyage Round the World." By Chas. Darwin. M.A., F.R.S.

always over some portion of the latter. Another fact which is here worthy of mention, is that of a rise of the thermometer to the extent of from one half to even two degrees, immediately in connection with the shock. The increase of temperature thus indicated, has been disputed by Gilliss, but the author believes it actually to occur.

These observations upon the causation of earthquakes, though made more directly in reference to South America, are equally applicable, it is believed, to all other parts of the world where these phenomena occur. In the case of the great Asiatic range — the Himalayas — it appears a fortunate circumstance that they do not stand, like the Andes, in a direction forming a practical and an extensive barrier to the prevalent winds, which supply the regular rainfall. Though their general course is practically parallel with these winds (not altogether so, in fact), yet local irregularities throw them, at points, into the attitude of barriers against such winds; and where they do so, the earthquake is invariably developed under the lee.

There are localities where earthquakes are frequent and destructive, the surrounding conditions of which would seem to negative the foregoing theories, so far as the question of *rainfall* is concerned. It is believed by the author, however, that all such localities are in the immediate vicinity of volcanic action.

CHAPTER IX.

The Forces of Nature.

In attempting to read and interpret the book of Nature, we discover, at once, what mere children we are, and how utterly incapable we seem, of understanding even its very rudiments. We are accustomed to speak of the "forces" of nature; but how little do we really know of them! What are these forces? We may answer readily, gravitation; molecular cohesion and chemical affinity; heat and light; electricity and the vital force; but in such an answer we but recognize effects, without approaching the question of causes. We take the known number, and let x represent the unknown, but with no apparent possibility of working out the representative quantity.

When we approach the questions underlying the secrets of the cosmos, we must do so only with the hope of being able to trace effects, and with no expectation of determining the inherent nature of cause. We may analyze to a certain extent, but we have no synthetic power. We cannot say *why* a stone falls to the earth when tossed into the air, but we *know* by observation that there is some agency which compels it to do so, if not mechanically impeded. And our knowledge does not stop with that. We know that its fall occurs with mathematical precision. We know some other things about it, too; and though we have never seen the face of our servant, we have learned his habits and his power, and have set him to do certain *work* for us, his capability for which, in particular instances, we find susceptible of precise estimation by figures and measures.

All this seems wonderful enough, but we have extended our knowledge so as to embrace useful information concerning the great worlds within our view; and still more wonderful, to estimate the character and weight of the ultimate atom of matter, which apparently lies as far beyond our vision as the essence which animates it. Hence it seems not at all improbable that we shall, at some time, be able much more completely than now to hedge and environ some of the profound mysteries of nature; and to unfold their ramifications to an extent enabling us to promote our further interests by the observed laws which govern them.

This is all, however. It is useless to speculate upon a subject belonging to the Infinite plan. We are children in comprehension, and it is better to adopt the philosophy of a child than attempt to be superhumanly wise. "Do you know what makes the ball always go up?" asked the author of a little boy with one of the pretty toy balloons filled with hydrogen gas, sold upon the streets. "Yes, sir," was the prompt reply. "Why, then?" "Because *it won't stay down.*" Like the prophet of the Hebrews, we may see the promised land from afar, but as mortals we can never enter it.

What have we settled then as to the "forces" of nature? Many things concerning their modes of action, as before said. As to gravitation, we have confirmed the law formulated by Newton. "Every particle of matter in the universe attracts every other particle with a force directly proportioned to the mass of the attracting particle, and inversely to the square of the distance between them." Gravitation then is a resident force which determines bodies to rush together. As between the particles of matter, it is designated molecular cohesion and chemical affinity, the force

being, without doubt, precisely the same thing in both instances.

Definition of Force and Energy.

With the modern developments concerning the transmutation of energy, there seems to have arisen a great deal of scientific looseness of expression in reference to the terms "force" and "energy," which tends to much confusion in the discussion of these subjects; particularly as the physicist's definition of the words is hardly the popular one; but rather technical in character.

Force, in general, as has just been said of gravitation in particular, is a resident property of matter which tends to create motion. We do not know, nor can we reasonably expect ever to know, the innate nature of this property. Science gives no interpretation of the essence, but only takes cognizance of the characteristics. Neither do we know whether the property be *inherent* to matter or *derived* from some other source; though it appears to the author *not* to be inherent in any sense. Neither do we know whether there exists but a single unit of force, or whether we have a number of force units. The author believes with those who maintain the former. But whatever its nature; whatever its source, and whatever its numerical attributes, it is the principle which underlies all *motion* in the universe — whether of gravitation, of molecular attraction, or of chemical affinity.

What then is *energy?* It is the *manifestation of force.* Force is the essence, and energy its representative. Force is the *power*, and energy the *action*. If a stone fall to the earth, force constitutes the *power* which determines its fall; but energy represents the *action* of the fall itself.

But the use of the word energy has been extended to express, not alone the idea of *activity in operation*, but also,

of *activity in repose*, paradoxical as the expression may seem. That is to say, energy may exist in a state of actual operation, as when a body moves through space; or it may exist by reason of the conditions upon which action depends having been complied with, although the action itself is not brought into present display; as when a body is lying at rest, at an elevated position, and only awaits the removal of the obstacle detaining it, in order to assume motion and fall through space as before.

Divisions of Energy.

Energy is of two kinds, therefore, which might best be named *active* and *passive*, but which are usually denominated *actual* or *dynamic*, and *potential* or *energy of position*, the former representing energy *in action*, and the latter energy *waiting for action*. The same idea was formerly expressed by the terms *vis viva* for the first, and *tension* for the second state.

The sum of these two energies in the universe is a constant quantity; and hence it is said that there is no such thing as creating or destroying energy, just as there is no such thing as creating or destroying matter.

Transmutation of Energy.

Our modern idea of heat says that it is not a substantial entity, as formerly supposed, but a species of motion, and therefore of energy; that when our hands are placed before a fire, the sensation we experience comes from molecules in active motion, and not from anything which directly enters the surface. Radiant solar heat is a molecular motion transmitted from the sun; while heat which *we* create, or more properly evoke, at will, is the product of *transmuted* energy. If energy be expressed in the form of visible

motion, and this motion be suddenly arrested, the energy is not lost; it is *transmuted,* partly into *heat,* still representing the *actual* energy, and partly into *potential* energy, that portion which is stored away for subsequent use or development. If a piece of ice be entirely melted, the apparent temperature of the water will remain precisely the same as that of the ice before liquefaction; and a like thing happens in vaporization—the steam will be no hotter than the water. What has become of the sensible heat in these processes? Is it lost? Not at all. It is very vaguely said to have become *latent.* In other words, it is no longer sensible to the thermometer; and it would appear, therefore, not to exist *as heat,* but to have assumed some other shape; perhaps, merely that of a requisite to overcome the form of energy represented by the tendency to molecular aggregation. It may be said, however, to be quite capable of reappearance *as heat,* under proper conditions. Hence, the energy may be constantly changing in form, now it is visible motion; now heat; but the resident something—the tendency to action, the *force,* is always the same.

If we get a clear conception of the atomic and molecular construction of matter, we shall not have much difficulty in understanding the modus of molecular motion as applied to the evolution of heat through transmutation of energy; but our present subject takes us beyond this question, and leads us at a later period to the consideration of energy in the animal system, with all its collateral bearings, and hence some study of the solar energy animating our planetary system is involved in the problem. Not only solar heat, but also solar light, are "forms or modes of motion." These seem indefinite expressions, however. What does the motion affect, or what does it represent?

The Physicist's Ether.

The idea of some subtle medium pervading all space was an intuitive suggestion with the very earliest of philosophers; but it was not until comparatively modern times that the conception was given a tangible shape. At this period, all scientists are in pretty close accord upon the general question of the existence of a fine medium, called the "luminiferous ether," which pervades all space, and the atomic interstices of all matter. Beyond this general basis of agreement, however, there is no settlement of details. Is the ether continuous, or does it float atoms of something, by which the motion is propagated? These are questions, not yet satisfactorily answered.

It seems a most difficult thing to conceive of the existence of a *continuous* ether, however fine or attenuated. There are some considerations which appear to render its existence impossible, while it cannot be said to explain many well-established facts. If we are to believe that heat is but a form of transmitted motion, it seems easier to fill our ether with atoms having an unrestricted play, in explanation of the well-known phenomena, notwithstanding the difficulties we have to reconcile in the conception, than to encounter the greater ones of a continuous medium. The wave theory of sound suggested the wave theory of light; and while this latter has fully explained many phenomena not so clearly explainable upon any other basis, as for instance those dimensions or measures of something connected with a ray of light, which are called light-waves or wave-lengths, yet it also raises obstacles requiring an imaginary constitution of the ether, most difficult to harmonize in its varied characteristics. We shall have more to say of the ether, a little further on.

The Conservation of Energy.

This is a subject which has pretty largely occupied the attention of physicists during the past decade or more, and some advances toward simplification and truth have, undoubtedly, been made. A few years since, it was general to call electricity a *fluid*, as though it might be bought and sold by imperial measure. Magnetism was a force, also, illy understood, and considered distinct from, although possessing many points of resemblance to, electricity. Heat was an entity, and light an emanation from luminous bodies. Some of the natural forces are now conceded to be convertible, one into the other; while there are not a few scientists who believe that every variety of energy has its origin in a *single essence*, as also there are not a few of them who believe there exists but one primitive form of matter; and therefore, that one force and one matter represent the inscrutable fiat out of which the Great Architect has constructed the cosmos.

As to force in general, it is a lofty conception which endows a single essence with such admirable and diversified attributes; and it seems but a question of time and inquiry as to when every form of energy shall be recognized as emanating from a single source; and that this latter is no more inherent to planetary systems than is solar light and heat.

Different States of Matter.

In relation to matter, the principles of chemistry are teaching us that *atomic arrangement* is capable of rendering two substances — identical so far as apparent elements go — as widely different in visible character and sensible properties as are, for instance, the ruby and a piece of magnetic oxide of iron; or as are butyric acid and acetic

ether, which have an identical composition and the same vapor density.

The whole domain of physical research teems with examples of the convertibility of matter, as well as of energy. Steam is but water, plus the energy of heat; and ice but water, minus the energy of heat. Carbolic and salicylic acids are two very different substances, chemically, as well as apparently. Yet salicylic acid, by the aid of heat, is rapidly transformed into carbolic and carbonic acids. From this it would appear that salicylic acid is but carbolic acid and the elements of carbonic acid, minus the energy of heat, and plus the energy of chemical affinity. It seems plain, therefore, that the combination represented by carbolic acid is a compound radical to other combinations, the best known of which is the salicylic acid, which latter exists naturally in many substances to be hereafter mentioned. Here the *energy* determines the combination, a fact which has a very important bearing upon other branches of our inquiry.

Concerning Oxygen.

If we search the entire field of known agents, we shall find one element, as it is considered, which seems to be, pre-eminently, the most diffused and universal of all others; entering more largely into the composition of animate and inanimate bodies, and apparently, more indispensable to the varied processes of life and matter than any other recognizable substance. It pervades all nature; forms about one half of all known material, and constituting one fifth part of our atmosphere, gives the latter a character through which, alone, man is enabled to exist. It is "the great supporter of combustion," not only in the material world upon which we live, but in our own bodies. It is eminently

a "vital" agent. In the form by which it is known to us, it is called *oxygen.*

The chemist will here tell us, that oxygen is not the only body with which we are acquainted, capable of supporting combustion; that a jet of hydrogen, for example, will burn in an atmosphere of chlorine. In this fact there exists an apparent exception to a rule which in every practical aspect may be said to be general; and as involving some interesting considerations, the body chlorine becomes a subject for more extended investigation. But in any event, this property of chlorine is limited, and the general attributes mentioned as possessed by oxygen, are not impaired thereby.

A careful consideration of the body oxygen in its varied aspects cannot fail to impress us with the idea, that taken all in all, it is the most wonderful substance of which we have any knowledge. It stands not only as a condition-precedent of animal life upon our globe, but in intimate association with various manifestations of energy. If we allow the calorific or invisible rays of an electric lamp gathered to a focus, to fall upon a piece of charcoal suspended *in vacuo*, the latter becomes heated to the extent of reflecting the red ray, and the coal glows with a simple red heat. If however, we let the same focus of calorific rays fall upon a piece of charcoal suspended in oxygen gas, the coal is at once ignited and we have a brilliant display of white light.

Let us reflect upon this matter for a moment. In the first place, the calorific focus thrown upon the carbon was only sufficient to excite in its atoms that degree of activity which gives evolution to the red ray of light; but when thrown upon it in presence of another agent the velocity of atomic movement was sufficiently great to give us the white ray — a union of all the others, and indicative of great veloc-

ity in the wave-swell. Of course, there can be no other conclusion than that the different results depend entirely upon the accompanying factor in the last experiment — the oxygen. The radiant heat is the same, and the body subjected to it, the same in both instances; and there can be no room for dispute as to the agency which produces the greater activity in the last case. But the chemist will now tell us, that we have only witnessed a simple example of combustion, whereby the carbon and oxygen have combined, chemically, with the evolution of heat and light and a display of incandescent particles; and that all chemical union is attended with this result to a greater or less degree. This is but the bare statement of a fact and explains nothing; we must turn to the physicist, therefore, and get his idea of the principle involved in the experiments. He will tell us that the carbon in the last case, having been heated by the calorific focus to an extent sufficient to permit an interlocking between the atoms of both bodies, union took place with the development of "energy" of such power as to excite the increased motion necessary to the production of the white ray.

But we wish to probe the matter more deeply if possible; we are following a subject destined to yield remarkable results in the future. It is impossible to dissect the ideal thing called "energy," but can we localize it? Is this remarkable property shared by both bodies equally, or more particularly by one of them? Let us try other experiments. Suppose we place the piece of carbon in a bell filled with chlorine gas, and project the heat-focus upon it. We shall have no such exhibition as in the case of the oxygen. Indeed, chlorine and carbon only unite, indirectly. Suppose then, we substitute hydrogen for the oxygen. Still we have no such result. Union between car-

bon and hydrogen is usually accomplished by the decomposition of complex bodies, and there are but few instances in which direct union takes place, although the hydro-carbons are multitudinous in number.

Let us take a glance at one of these compounds — methyl hydride (CH_4). This gas is evolved silently through thed ecomposition of other bodies, but when mixed with oxygen or even atmospheric air, a violent explosive mixture is formed, from which many deaths have resulted in coal mines. Let us take away the carbon of the above named gas, and put the hydrogen with oxygen in the proportions to form water. The application of a spark will evoke an "energic" manifestation of light and heat which immediately informs us, that we are dealing with an agent whose voice we have heard before. If we wish to get some idea of the nature of this "energy," let us conduct the gases to a common jet, and light them at their emergence. The intense heat of the oxy-hydrogen blow-pipe will announce the *energy* bound up in these invisible bodies.

Not to enter into too great detail in a work like this, it may be said that even to the most inexperienced, who are satisfied with the indefiniteness of such a term as combustion, it must appear that oxygen is a body possessed of very singular properties; while to him who is accustomed to the observation of nature's processes as witnessed in the laboratory, there will be suggested many illustrations of the fact that it stands alone in peculiar features; and further that its presence and action represent a *maximum of energy possessed by no other body.* This latter statement will be objected to by some as involving an idea opposed to general theories; but the author believes that careful investigation will sustain it.

Nature of the Ether.

Whether force is inherent to matter, or is a transmitted property, we have as little idea, as before said, as we have of the innate nature of force itself. Beautiful as are the theories of light and heat as resting upon the conception of the ether, it would seem impossible to admit that their correctness is even an approximately demonstrated truth. There are a number of facts which render the various features of these theories very difficult of reconciliation. Some of these, as the author thinks, grow out of certain considerations connected with phenomena attending the polarization of light; others with the ether itself. If, for instance, the ether possesses an elasticity sufficient to project a wave of light at the velocity of nearly 200,000 miles per second, it is susceptible of mathematical showing that the density of the ether must be vastly greater than that of common air, which we know not to be the case. That it has, however, some substantial attributes, and is not the very attenuated medium claimed, must be conceded, if we are to give credence to those astronomers, who declare that the orbits of comets and other cosmic bodies are becoming more and more contracted as the result, not alone of gravitation, but of friction.

When a spark from an electrical machine or a flash of lightning passes through the air, we witness a vivid white light. The popular mind associates with these phenomena the passage of a substantial body over the field of action. Our modern science has taught us that this is a delusion; and that what we really see is the white light produced by intensely heated particles of something ordinarily invisible to us. What is this something?

Under the lights of our present knowledge, we have no

right to say that the ether is but a passive agent of conduction, and without positive properties of its own. Indeed, from a close study of all these intricate processes of nature, one is tempted to believe that, in creating a mysterious thing called "force," as the origin of all motion, and another thing called the "ether," as its simple agent of transmission, we have not at all reached the bottom of the matter. In every earnest and unenthusiastic investigation, there appears the shadow of an unknown thing flitting through these processes; indefinable, to be sure, but as plainly visible to a close observer as the little markings of the light-wave. In the earlier years of the human race, a shadow upon the moon announced the sickness of the latter body, which the beating of a tom-tom was sure to remove. As time rolled on, however, the course of the malady definitely settled two things: first, the revolution of the heavenly bodies; and second, the rotundity of the earth. The future centuries may catch and fix the indefinite shadow spoken of, if the substance itself lie not too far beyond the line bounding our finite understanding.

The Source of Energy.

If the positions which the author proposes taking in another part of this volume, upon the question of energy in its relations to the animal system, have any strength, a few moments of time will not be lost in briefly touching upon the source of energy within our own planetary system.

The sun is supposed to be the original entity from whence proceeds the heat-energy which animates and keeps in motion our system. No theory of how this heat energy is produced has as yet received universal acceptance. The old belief that the sun was a body in actual combustion has been abandoned chiefly because the evidence is now con-

clusive, that it burns as brilliantly to-day as it did millions of years ago, having suffered no diminution of action, as must have been the case were a process of simple combustion involved.

The prevailing opinion refers the sun's heat to a transmutation of visible motion, brought about by the impact of condensation while in the nebulous state, whereby the actual energy of motion was converted into heat, etc. This theory, while perhaps the most plausible we have, is still unsatisfactory. The demonstrable sameness of surrounding systems, negatives any other idea than that the entire universe has been constructed upon the most precise and definite plan, nothing whatever having been left to the peril of chance or accident. In such an inquiry, too, the mind naturally goes back to the source of the *original* energy, which distributed the parent stock to the solar systems; and this inquiry extends itself, with equal force to those erratic bodies of cosmic matter whose continual falling into the sun augments the solar heat. Energy from some source is original, and must of necessity have emanated from some centre of force; the primitive supply was precise in quantum or amount, and from the beginning of all things nothing has been actually gained, nor lost; though it is claimed that the balance of the various energies is being gradually disturbed.

If the sun derived its energy from another point, our inquiry must at once go back to that point. We cannot reason in a circle; nor in explanation of cosmical phenomena, refer force to force, for thus we only leave the question where it was.

As it would appear that different forms of energy but represent different *states* or *conditions* of an unknown something, the supposition does not present itself as an

impossibility, that there exists a great centre of cosmic energy, *forming the pivot of the universe,* from which the solar bodies receive, and then transmit it, as distributing points in the forms of light, heat, and electricity (?) to their respective systems. This may be considered an extravagant speculation; but it seems not unreasonable to suppose that the centre around which all systems must certainly revolve, has an attraction proportionately great, at least, for its systems, as the solar bodies have for their own satellites; and that it imparts the energies of light and heat to the former, as our sun imparts them to his company of dependents. In looking from our planet into space, we do not see, to be sure, any blazing mass which to the common mind represents the sun of suns; but if it were possible to stand upon our own sun, ninety-six million miles distant, and sweep the horizon, a different view might be presented.

These are questions, however, which, while of absorbing interest to the general philosopher, can never be definitely settled by him; and as it seems, there is presented no alternative other than to remit them with all their yearning outgrowths, to the profound depths of the *Quien Sabe!*

CHAPTER X.

Oxygen and Electricity.

When treating of the principle denominated ozone, in another portion of this volume, the author stated this body to be, in the general opinion, simple oxygen in an allotropic condition. The word allotropic only means *a change*, and while convenient in some respects, conveys no definite idea of the precise nature of the change to which it refers.

Whether or not the allotropic condition consists in a molecular condensation, and a consequent multiplication of atoms in each molecule; or whether it represents a modified arrangement of the atoms themselves, need not here be inquired into. It is sufficient for present purposes to know that this condition as pertaining to a number of bodies, if not universal to all, is generally conceded. Carbon presents us three well-known modifications, as illustrated by the common lampblack, the plumbago or graphite, and the diamond. Phosphorus presents the red and vitreous states, the former permitting it to be handled, and even carried about the person without the danger of ignition; the latter going off in a blaze under the temperature of 140° or less. Dr. Draper, of New York, has shown that chlorine exists in an active and a passive state; in the first of which, all its well-known properties as a bleacher, disinfectant and deodorizer are manifested; while in the second, even its most energetic properties are nullified. Sulphur is another example of a body susceptible of allotropic or changed forms; and as a summary it may be said, that there is a

strong probability that all known elements are endowed to a greater or less degree, with the property of existing under two or more forms.

Oxygen, as being concerned in the combustive process, has a close relationship with the energic manifestations of light and heat. It has interesting points of contact, likewise, with the electric energy, which, as it displays itself to us, is but a transmutation of other forms. Heat is convertible into electricity, and the latter into the former. A bolt of lightning may fire a house; and striking on a sandy surface, will often vitrify a stone lying sufficiently near the point of impact, covering it with a coating of glass as perfect as any made by artificial process. The silent spark of electricity passed through pure oxygen, condenses the latter and forms ozone. The application of heat, will then destroy the ozone and expand the oxygen; and this process of conversion and reconversion may be carried on with the same oxygen, again and again.

Oxygen is closely allied with the chemical production of electricity, and also has remarkable relationships with light, possessing the smallest refractive powers of all known substances. It, also, has decided, if weak, magnetic properties.

These facts are rehearsed in order to illustrate the varied relationships of oxygen in the economy of nature. As a body concerned in the changes occurring under the denomination of the "combustive" process, it is a substance of much interest, though the process itself seems to consist simply in recombination, whereby all the substantial factors originally involved are susceptible of being accounted for. As a body, however, through whose direct agency many of the manifestations of actual energy are evolved, to a greater extent than by any known substance possessing even the

tangible character of this gas, it is full of suggestive possibilities. Potent as is its agency in the purely physical operations of nature, it becomes a still greater power in the operations of animal life; and in this connection the author must refer to it in subsequent pages.

CHAPTER XI.

The Volcanic Pile.

The preceding remarks upon the agencies involved in the production of an earthquake, would be incomplete without a few words, at least, upon the subject of volcanoes, with which the popular mind has been led to associate all of the phenomena of the former. The real fact is, that earthquakes may occur quite independently of any connection with volcanoes. The latter exist, to be sure, in the elevated chains of mountains, behind which the former are constant; and when in eruption, or as preliminary to an eruption, earthquakes are manifested in all degrees of violence. But the earthquakes of South America often occur in regions entirely separated from volcanoes by strips of entirely unaffected country; the action of the former is distinctly marked out and limited, and it is impossible to regard them as an exclusive consequence of volcanoes.

Whether or not the interior molten condition of the globe, assumed by scientists, exists as a matter of fact, need not now be discussed; though the writer states frankly, that he cannot believe it necessary to explain volcanic eruptions upon that ground. That the earth is an enormous magnet has long been maintained. Gilbert, surgeon to Queen Elizabeth, in his work *De Magnete*, declares that the whole globe is held together by the electric force*—rather remarkable language for the early part of the six-

* Globus telluris per se electrice congregatur et cohæret. Quoted by Humboldt in the "Cosmos."

teenth century. We can fully appreciate the truth of this assertion in our own day, when the wondrous feats of the telephone are about being accomplished over wires, without batteries to generate currents; but acting alone by the natural currents of the earth.

If the boiling, seething mass of internal fire really exist, the production of electricity as a representative of transmuted energy, is easily accounted for. But it requires no stretch of the imagination to suppose a naturally existent store of this form of energy, constantly disturbed and perhaps augmented by the varying conditions of solar heat, and friction produced by the earth's rotation upon its own axis, as well as by its revolution around the sun. That varying electrical states are largely produced by the sun, is now well proven in connection with observations, showing the greatest magnetic disturbances of the earth, to occur during the maximum of the sun-spots, observed about every eleven years; when sanitary conditions are likewise affected. Hence, as the author believes to be the case, it would be entirely possible for volcanoes with their accompanying eruptions, to exist without any permanently molten condition of the interior of the globe, but as a pure and direct consequence of electrical action.

In reiterating, then, the assertion that the immediate cause of an earthquake, that "spasmodic convulsion of the sickened earth," is not a simple vibration produced by concussion at a distant point, nor the wave motion of an internal fluidity, but the actual transmission of energy, closely related to, if not identical in form with electricity, the author desires to be construed under the light of the preceding reflections and arguments. This much, he can assert without hesitation: that in the field of his recent observations, where earthquakes from some cause are fre-

quent and destructive, certain accompaniments are invariably to be noted—one of these being the elimination into the atmosphere of a substance responding to all of the tests for ozone; another being a highly electrical condition of those localities, as manifested in the methods heretofore described. These are the potent facts, which it has been the chief purpose of the author to demonstrate. The application to the strict sphere of the pathologist, if they really possess any, remains to be made.

PART III.

MEDICAL ASPECTS OF THE PACIFIC COAST OF SOUTH AMERICA.

CHAPTER I.

General Considerations.

To attempt a full description of the sanitary peculiarities of a belt of country, passing through a range of from 40 to 50 degrees of latitude, and extending from the equator to the lower part of the south temperate zone; and affected as it is, in different localities, by complicated questions of altitude, wind exposure, rainfall, etc., etc., as may easily be seen, would require a volume of greatly larger proportions than the present. The author's immediate object is, simply, to note the salient points connecting physical features and circumstances with prevalent health states or types, with the view of discovering whether or not, it be possible to deduce therefrom, any laws and principles tending to throw light upon the obscure questions of general disease causation.

Two propositions may here be announced: first, that throughout the wholly rainless districts of the above mentioned coast, and with the limitation previously mentioned, in those where the *earthquake energy* is most strongly and constantly developed, the existence of a large number of the infectious diseases, which devastate other parts of the

world, is unknown; and second, that in such portions of it alone as possess a rainfall* during a limited part of the year, are any of these diseases to be observed; and then, perhaps as a rule, after the winter earthquake season has passed.

If these propositions be susceptible of verification, the facts involved cannot be accidental; but, of necessity, must be underlaid by some fixed condition or conditions operating with the constancy of a specific law. What are these conditions? If we could define them with the certainty of a settled problem in mathematics or in physics, we should be in a position enabling us to comprehend more intelligently many of the obscure processes of animal life; and as an ideal conception, to stand upon the shores of our unknown sea, and bid the waves advance no further than a given point.

The question is one vast in proportions as well as in consequences; but we may narrow it down and prune it to the root in order to grasp its logical characters, and follow it to the last conclusion.

The explanation, then, of the exemption spoken of, can only lie within the two circumstances of geographical inaccessibility to general contagious intercourse with other parts of the world, and the local facts of physical construction or existence belonging to the region under consideration. Now, it cannot come within the first of these, because steamers ply up and down the coast from all parts of the world, with none of the restrictions of a comprehensive quarantine to bar off the advance of infection. The ports upon the Chilean coast are but from eight to twelve days from the yellow fever and cholera foci of Brazil and other Atlantic ports; while the city of Guayaquil is but four

*The author here includes under the word *rainfall*, those heavy mists, (*garuas*) which regularly occur on certain parts of the coast; as to all practical purposes, they are equivalent to light rains.

days', Payta but five days', and Callao but seven days' steaming from the Isthmus of Panama, that great international highway between the Atlantic and Pacific oceans. Further than this, one of the infectious diseases — variola — has been introduced into certain parts of this region, and has a curious and perhaps an instructive history, hereafter to be mentioned; while it is claimed that others have also been introduced. Hence the ground of geographic isolation is not tenable in explanation of the facts of exemption; and we are driven to the remaining alternative of pure physical circumstance.

Having arrived at this point, we are at once confronted with the difficulties of the situation. What physical influences exist capable of averting from the inhabitants of this region a class of diseases furnishing so wide an outlet to human life in other parts of the world? What are the salient facts as illustrated in the foregoing description of the physical peculiarities of the southwest coast? They are two — first, varying degrees of atmospheric aridity, and second, a highly electric condition giving rise to frequent and violent disturbances of the earth and air.

Let us prune the question still further. If the infectious diseases, as is now claimed, originate from the direct influence of atmospheric germs, is not the exemption explicable upon the simple fact of an atmospheric aridity unfavorable to germ life and development: and is not this fact itself a strong proof of the correctness of the "germ theory"?

The experiments of Pasteur with hermetically-sealed flasks containing organic matters, upon the *Mer de Glace;* and of Tyndall in the air of the Jura mountains, have definitely settled a fact, again to be alluded to in these pages, viz: that living organisms not only spring from a typical

parent, but that the precise conditions under which each form is capable of existence are marked with the most rigid exactness. The remarks hereafter to be made in this volume, concerning the existence of life under certain specified conditions are also applicable to the point now being considered. The various forms of animal and vegetable life on the southwest coast have an interesting relationship to that wonderful mountain-chain, which, in the language of Coleridge, may be poetically described as

"A living ambassador from earth to heaven."

But, in special reference to the organic forms involved in our present question, it may be stated, that at all ordinary levels they exist in the atmosphere of the region under consideration, whatever may be its actual rainfall; for it must be remembered that mountain streams of large size in past ages, as some of them still are, have formed immense valleys, through which water finds its way, keeping the air of the vicinity charged to a certain degree, by constant evaporation. Further than this, the most of the large cities are either directly upon the sea coast, or in its immediate vicinity, where no lack of humidity exists; while in some parts, notably in Callao and Lima in Perú, the dews are so heavy as to resemble light rains. In some of these places, dampness is proverbial, and much care is often requisite to preserve the most ordinary articles from mildew.

In all these regions there exist special endemic diseases, as the *chabalongo*, or "typhoid fever of Chile"; and the undisguised malarial or periodic fevers of Lima and vicinity. More forcible still, however, is the example of localities having a regular rainfall, equally exempt from many of the infectious diseases. Of these there may be specially mentioned the cities of Guayaquil and Quito in Ecuador, where epidemics (except as hereafter to be mentioned) do not

prevail; but where the rains are copious, vegetation rank, and the electric energy intense. As conclusive upon the point, the writer in his own experiments never failed to observe varieties of bacterial life from exposure of organic solutions in the Chilean atmosphere, as high as a level of 3,000 feet above the sea.

From these considerations we are bound to conclude, that the exemption mentioned cannot rest upon any anhydrous condition of atmosphere forbidding the existence of aërial germ-life; as also that the circumstance lends no support to the hypothesis, which constitutes bacteria the specific causes of the infectious diseases.

CHAPTER II.

Sanitary View of Principal Cities.

As preliminary to subsequent remarks upon the general topic embraced under this portion of the present volume, let us take a rapid survey of the prominent sanitary peculiarities of those portions of the south Pacific coast, affording the most striking contrasts, as considered from the standpoint of our subject.

Ecuador.

The city of *Guayaquil* is situated upon the river Guayas, and lies but a short distance below the equator. The rainy seasons are regular, and the rainfall copious. The valley upon either side of the river consists of a rich alluvium and supports a handsome, tropical vegetation. The whole region teems with insect and parasitic life; and during the rainy season, violent local fevers and dysenteries of low types, are prevalent. With the exception of variola, however, it is to be doubted that the class of infectious diseases to be considered in these pages, have ever visited Guayaquil. It is claimed that contagious yellow fever has scourged the city; and while we might expect, as the locality falls directly within the limits of the natural home of that disease, that this would be the case, the evidence is not entirely conclusive, that the disease there called yellow fever, is other than a violent form of bilious remittent fever.

Passing, however, to a mountain elevation we come to *Quito*, nearly upon the equator, and almost 10,000 feet

above the sea, and also possessed of great medical interest. Here the rain is copious during the proper seasons, and vegetation perennial. The city has a population of 40,000 people, living in the most primitive style of dirt, sloth and exposure; and yet enjoys a salubrity which might excite the envy of the best regulated capitals of the world. In relation to this point, the following quotations may be made from a book * by the Hon. Frederick Hassaurek, formerly U. S. Minister to Ecuador, the accuracy of whose observations is only equaled by the delightful style in which they are recorded. Says Mr. H.:

"If it were not for the excellence of its climate, which is never hot and never cold, the prevailing filthiness would make Quito a very sickly place. But as it is, Quito with its neighborhood for miles around, may be said to be one of the healthiest localities on the globe. Consumptions and pulmonary diseases are scarcely ever heard of. The fevers peculiar to tropical countries are unknown. Those who get them on the coast will go to Quito and the interior to get rid of them. Dysenteries are uncommon. Among the rabble, it is true, cases of tubercular elephantiasis or leprosy, as well as blindness and deafness, will be noted; but there is no doubt that they are brought on by irregular habits and the indescribable filthiness in which these people are brought up and live. . . . To judge from the great number of people of high age I have met with in all ranks and stations, the climate may be said to be favorable to long life. . . . Cases of sunstroke are never heard of," etc. etc. And as touching a point to be again mentioned in these pages, the following is further quoted from the same book: "Not only is Quito a very healthy place, but it is without insects, except those against which cleanliness is a safe

* "Four Years Among Spanish Americans."

preventive, such as fleas and lice. . . . For leagues around Quito no snake is to be found. Mosquitos are hardly known; scorpions and tarantulas have never been heard of. Flies even are very rare, and do not molest at all. There are mice, but no rats, nor are there bats or lizards, or even bugs or beetles in the grass or on trees."

To this statement it must be added that the city enjoying such rare immunities, lies at the base of Mount Pichincha, and within calling distance of Chimborazo, Cotopaxi, Sangai, Tunguragua, and more than a dozen others of the volcanic kings of the Andes, and where the purely *volcanic* earthquakes, if the expression may be used, are largely represented, as well as genuine storms of thunder and lightning.

In relation to the absence of venomous reptilian life, as stated by Mr. H., it may be further added, that it is quite characteristic of the whole south Pacific coast, that venomous reptiles and insects have no natural existence. What effect the peculiar conditions of a volcanic and earthquake region may have upon such forms of life need not now be inquired into. The circumstance will be referred to in another portion of this volume.

Perú.

Descending from this interesting locality to the sea coast we come to the little town of *Payta*, on the arid coast of Perú, in latitude 5° S.; and where, until the present season, rain has not fallen, it is said, for forty years. This is one of the healthiest spots on the face of the globe. Though the inhabitants are compelled to carry their drinking and cooking water a distance of several miles, and live in that flagrant violation of all sanitary rules, which generally characterizes, in varying degrees, the whole Spanish-

American population, epidemic diseases of all kinds are entirely unknown; while individual sickness among the unwashed residents, is so rare as to constitute quite an event.

Payta is but a port for the interior, and for the commonest necessaries of life, is dependent upon the back country, and the ships which visit it regularly. The soil is composed entirely of sand; and vegetation in any natural form does not exist, if we except the small forms of vegetable life which have an ephemeral existence after a phenomenal rain. An amusing incident grew out of this circumstance, which the *Paytaguinos* appreciate as highly as the traveler, who visits them. Several of the inhabitants having died, from time to time, of old age, and violence, it was thought necessary to have a graveyard; and accordingly a small piece of ground was fenced in with closeboards. To relieve the natural lack of verdure, an artist was employed to *paint* trees and shrubbery on the fence, which he did with much skill and greatly to the admiration of the people. An unforeseen difficulty, however, soon presented itself. The entire *mule* population of the vicinity made a rush for the shrubbery, and inflicted great damage by constantly gnawing the fence. Their forays were prevented, at length, by painting the foliage of a *blue* color; and the board fence and blue trees are the first objects the traveler now witnesses, upon approaching Payta from the sea.

Proceeding south along the coast, we reach *Callao* and *Lima*, in about 12° south latitude, the latter capital being the ancient "city of the kings." Here the malarial influence (the specific remedy for whose effects on the human system, in shape of the famed Peruvian bark, is found indigenous to a not very remote locality) exists in consider-

able intensity, and periodic types mark nearly all diseases of that particular region. As the author will have occasion to refer more than once in these pages to a specific influence endemic to Perú, the circumstances of its development may be appropriately related at this point.

The Verruga Fever.

When the Oroya railroad was being built — a road projected to connect the Pacific coast with the head-waters of the Amazon river — the workmen, upon breaking ground on a certain spot nearly 6,000 feet above the sea, were prostrated with a disease which received the name of "Verruga fever" (*la fiebre de Verrugas*), from its accompanying eruption resembling a wart. The precise nature of this malady is entirely unknown. Though designated as a fever, the author has been told that the disease often appeared without fever, being ushered in with violent aching of the joints, which was soon followed by the eruption. This latter consisted of a warty tubercle, varying in size from a pea to almost that of a hen's egg. The latter was hemorrhagic in character, and rapidly reduced the patient's strength through loss of blood. It has been generally claimed that the disease was peculiar to the spot before mentioned, and a bridge constructed over a chasm at that point is called the "Verruga bridge." Dr. Edwin R. Heath, for some years in charge of the hospital at Chileta, while the Pacasmayo road was being built, and a gentleman of much learning and observation, maintains that other localities in Perú produce the disease, and that it was known during the Spanish conquest.

However this may be, its existence is certainly very circumscribed. Only those immediately exposed to emanations from the upturned ground were affected by it. Qui-

nine was powerless to prevent or cure, and stimulants and tonics were exclusively relied upon to combat it. What mysterious and pestiferous agency lay buried here from the ages when the Andes rose from the sea, ready to spring upon the advances of civilization, and dispute those lofty mountain passes even with the iron-horse, more invulnerable than his wooden predecessor before the walls of ancient Troy? The march of time may solve a question to which the science of our day gives no response. The author has some notes concerning the physical features of the spot, made by himself when passing over it about one year since, the statement of which, though shedding no positive light upon the subject, may be of interest in a future volume.

At this point the remark may be made that, as we progress southward from Perú, the malarial influence steadily diminishes, until long before the Chilean coast is reached, it is lost entirely.

Bolivia.

The interior of Bolivia is a region of marvelous interest, though from the circumstance of its inaccessibility, little concerning it is generally known. There are no seaports of any consequence, and its capital, until recently, was reached by mule travel over mountain and desert. The remarkable electrical conditions of the interior mountain regions are the subjects of stories which might completely dwarf those of Baron Munchausen were it not that some basis for them is positively known to exist.

All reports of the interior cities of Bolivia and their cloud-dwelling populations represent them as remarkably healthy, notwithstanding their habits of personal and general filth and insalubrity. No epidemics are known to exist, and were it not for the prevailing habit of killing each other in revolutions, it is believed by those competent

to judge that no region of the known world could present such tables of health and longevity. *Cuzco*, the ancient capital of the Incas, and the site of the beautiful Temple of the Sun is nearly 12,000 feet above the level of the sea.

Chile.

The author is able to give a much more extended account of the sanitary conditions of this country, than of those previously mentioned, because of a lengthened residence in that republic, for a period of nearly four years. The limits prescribed for this little book, however, will permit such details only, as may best serve to point and illustrate its main purpose.

The cities of *Valparaiso* and *Santiago*, situated near the 33d parallel of south latitude, the former upon the sea coast, and the latter in the interior, are the largest cities of Chile. Valparaiso contains about 110,000 inhabitants, and Santiago with its suburbs, about 200,000. There is no other city in the republic of over 30,000 people.

The city of *Valparaiso* (the vale of Paradise) is built at the foot of an amphitheatrical chain of coast hills, upon a strip of land so narrow that a large portion of the new city is constructed upon the hillsides and within the ravines (*quebradas*). The streets are narrow, and the population exceedingly crowded. There being no stream of pure water accessible to the city, this great necessity is chiefly supplied by reservoirs filled during the rainy season. The quantity of the supply is therefore very precarious; always so limited as to make it a sort of treasure to be husbanded with care; and at times, if indeed this be not the rule, the quality is so bad as to render it quite unfit for drinking purposes. Though there exists an attempt at a sewer system, it is an open question whether or not the sewers are not more per-

nicious than healthful. During the summer season, the scarcity of water renders the proper flushing of closets and sewers, alike impossible. Hence, accumulations occur giving origin to the gases of putrefaction, which are freely emitted in dwellings, as well as in streets. When the winter rains come, a general washing out occurs; and if, as occasionally happens, the rains are very heavy and prolonged, the violent rush of water down the steep hillsides and *quebradas*, tear open the sewers, and fill the air with their reeking odors. Add to these insalubrious conditions, a laboring population dwelling in huts, and living in filth, and it can easily be seen, that Valparaiso should be a city scourged with epidemics, and presenting a mortality rate equal to the most unfavored spots in the world.

And yet it is not so. The climate of Valparaiso is quite delightful. From its latitude and position at sea level, presumably it should possess a very elevated temperature. Two circumstances prevent this, however; first, because of the cold ocean-current of Humboldt, which sweeps up from the Antarctic seas, and bathes a great portion of the south Pacific coast; and second, because of the fresh sea-breeze regularly blowing over the city. Now to this latter agency may largely be attributed whatever healthfulness the city may possess, as through its means not only are the noxious gases of the place blown away, but a plentiful supply of the ozone principle is furnished, to disinfect them.

So far as the central streets and external appearances are concerned, Valparaiso is kept scrupulously clean; but through lack of water, as before mentioned, it is impossible to institute safe hygienic principles and laws among a large population, crowded into a space between the sea and coast hills, probably not averaging a quarter of a mile in width. And yet with all these disadvantageous surroundings and

accompaniments, epidemic diseases, with the exception of small-pox, and erysipelas, are unknown in Valparaiso. It may here be added, that during the winter months, earthquakes of violent character afflict the city.

Santiago, the capital of Chile, is situated upon a broad and fertile plain, at the base of, or within full view of the great snow summit of the Andes. It lies at a level of 550 metres, or 1,787 feet above the sea. Unlike its seaport, Valparaiso, it has ample space for its population, and enjoys a plentiful supply of delightfully pure water, brought directly from the adjoining mountains. It has a fine climate—the thermometer seldom or never falling below 40° of Fahrenheit's scale; nor rising above 68°. Under proper sanitary regulations, it should be one of the healthiest cities in South America. The drainage of the city is effected by an innumerable network of little canals (*acequias*) walled at the bottoms and sides with brick; and through which flow streams of running water. These canals permeate the whole city, running under houses, and through the yards; and receive every describable variety of refuse belonging to a population of 200,000 people. Their tops, however, being open in many places, such gases and the living organisms, which they might naturally contain, have full access to the dwellings. Were it not that the descent of the canals is naturally great, owing to the inclination of the city from east to west, the consequences resulting from open conduits of filth and putrefaction would be of a most serious character.

In the matter of dwellings, there are few houses in Santiago, constructed upon approved principles of hygiene. They are largely built of *adobes* (sun-dried brick), and having no foundations, the walls of the lower stories are pretty constantly damp and even wet during the winter season.

As a rule they are badly ventilated; and being built upon the plan of a hollow square, with intervening courtyards (*patios*), the sun seldom penetrates the living rooms. The *altos* of houses containing a second story, are not open to these objections. The poorer population live in all sorts of huts and holes, loaded with filth and foul air; while not a few sleep under the broad canopy of heaven, with the never absent *poncho* as the only covering. During the heat of the summer months, so soon as the sun goes down, a current of cold air begins to flow from the adjacent ice-fields of the mountains into the superheated valleys below, making so great a reduction of temperature, that one must sleep under blankets the whole year through. Hence the exposed peasantry are subjected to the full effects of these alternations of temperature. During the wet, winter months, the terrifying earthquakes are frequent and regular phenomena; and occurring usually during the night, the whole population, rich and poor, are liable to exposure to the inclemencies of the weather.

These observations pertain to nearly all of the cities and districts affected by earthquakes; and as might be supposed, the effects upon the health of the people are of the most decided character. But the class of diseases from which they suffer most largely are those naturally resulting from the influences herein set forth; hence, pneumonia (*pulmonia*), is not only a frequent, but from its asthenic character, a very fatal affection; constantly heading the list of the ordinary mortality tables. This asthenic character pertains to all classes of disease; and is due, evidently, to the deranged innervation necessarily attending a residence, native or even prolonged, in regions of the world marked by the electrical conditions of violent earthquake districts; and contributed to by an almost dead-level temperature throughout the year.

CHAPTER III.

Prevalent Diseases of Chile.

This interesting country has few diseases which are entirely peculiar to it, though the remarkable physical conditions of this, as well as of other portions of the south Pacific coast, induce particular types which mark all classes of disease. The most usual affections are those of the respiratory organs, embracing nasal catarrh, pneumonia, bronchitis, pleurisy and phthisis; hepatitis; rheumatism; valvular diseases of the heart; diarrhœas; neuralgias; goitre, and affections of the eye.

Prevalent Infectious Diseases.

Chabalongo, or "*Typhoid Fever of Chile.*"—This is a peculiar fever, and seems exclusively endemic to Chile. It frequently becomes epidemic in the large cities, and though not communicable, it is evidently a disease of *specific* origin. What may be the nature of the causative principle is as undetermined, as is that which produces the malarial and typhoid fevers, or any of the affections classed by some authors under the name miasmatic-contagious. Special conditions of filth engender the disease, and its chief ravages are among the indigent and vicious classes of the population; though during epidemic visitations it attacks the better classes, in a mild form. Like the Verruga fever of Perú, it is essentially of a low type, though unattended with any characteristic eruption. Its most usual sequel is

falling of the hair, from which result its name is derived. In its worst forms, it has been regarded by the Chilean physicians as identical with the typhus of Ireland, as the latter has been described by Graves and Stokes. The writer was unable to form this opinion of it, from his own observation, but considered it a pure *locality* disease. Quinine has no specific influence in arresting it.

Erysipelas.—This disease becomes epidemic at intervals, and assumes a hemorrhagic and gangrenous form, being productive of great mortality, especially among puerperal women, in whom it is developed as a metroperitonitis. Its ravages are greatest in those with an impoverished or altered blood-state, and with depressed nervous energy.

Dysentery.—This disease prevails largely during the summer and fall seasons, as a sporadic affection, chiefly among the poorer classes, who indulge in, and may be said almost to live upon watermelons (*sandias*). During certain seasons and periods, the disease becomes epidemic, as in other parts of the world. It has no peculiarities other than that of its early asthenic character.

Hooping Cough.—This affection, undoubtedly prevails, at times, in both Santiago and Valparaiso, but its attacks are usually mild in character, and not often followed by serious sequelæ.

Influenza.—This affection has prevailed as an epidemic, at various times, upon the whole coast. Influenza does not depend for its spread over the world upon lines of travel or of human intercourse, but appears spontaneously in the most remote and inaccessible localities. Its origin at particular seasons and periods, and in utter disregard of all health conditions, inevitably connect it with meteorological states, probably induced by magnetic influences of terrestrial or solar character. In the sense only, of its being

epidemic or pandemic can it be considered an infectious disease.

Syphilis.—The ravages of this disease and its sequelæ are frightful, general ignorance and unrestricted intercourse among the lower classes permitting it to work its maximum of mischief. The field is a good one for the study of the malady in all its forms.

Small-pox.—The physicians of Chile cannot tell when or how this pestiferous disease was introduced into the country, further than to state their belief, that it was originally brought by vessel from the Atlantic coast, and at once found a congenial nidus in the filthy habits and abodes of the lower classes. However introduced, it seems never to be entirely absent; while at intervals it assumes the epidemic form and rages with much violence, it being estimated that the mortality sometimes reaches as high as fifty per cent of the existing cases. It is confined in its attacks, however, to the cities, and to their slums of poverty and filth — a case seldom ever being heard of outside of that charmed circle. Living in dirt and squalor, suffering from exposure to the wet, winter weather, and subjected to those peculiar influences of locality heretofore stated, which expend their force upon the nervous system, is it to be wondered at, that the disease assumes the confluent and hemorrhagic forms, and more than decimates the unfortunate victims?

But there is one very remarkable peculiarity about small-pox, which characterizes it, so far as the author could learn, wherever it prevails throughout the whole region of country now under consideration. The disease seems to have lost, in great measure, *its identity*, and to have merged itself into a local disease — local, that is to say, to the extensive tract subject to the physical states heretofore described. The most peculiar of these, aside from some general de-

partures from the usual characteristics, relate to the *inefficacy of vaccination as a preventive,* and *the non-protective power of one attack against another.* It has been claimed, as an explanation of the first circumstance, that the vaccine virus in being brought through the tropics deteriorates; but this can hardly be the proper one, as the utmost care has been taken to transport pure fresh lymph from the calf, in sealed tubes, kept during the voyage at a low temperature, and excluded from light. That the fault cannot be with the vaccine lymph is evidenced by the second circumstance mentioned. There can be no doubt that many persons have the disease three times, and the writer has seen those who claimed to have had four violent attacks. These features characterize the disease in Perú, where it also prevails, as well as in Chile and elsewhere. The disease, without doubt, was introduced to the Pacific coast as veritable small-pox, but some mysterious influence has stripped it of its most characteristic features. The author believes the malady, as it now exists, to be entirely susceptible of being "stamped out" from the whole region by proper and persistent effort; and during his residence upon the coast, took occasion to indicate the measures which he believed would be effective in this direction, in a published essay upon the subject, entitled: "*Los Medios Mas Aprobados para Prevenir la Viruela y Otras de las Epidemias.*"

It may be said that the list of infectious diseases prevalent upon the southwest coast is complete with the foregoing statement. It has been claimed that others of the class have from time to time appeared, as will be mentioned presently. It is admitted by all observers, however, that ravaging epidemics afflicting other portions of the world with such great mortality, are entirely unknown by like

results in any portion of the extensive region under consideration, with the exception of small-pox heretofore mentioned; while in those having no rainfall whatever, and as a consequence characterized by the electrical states of earthquake regions, such diseases have no existence; a rule seeming to be, that the prevalence of the general class of acute infectious diseases is *inversely to the electric energy of the locality.*

Infectious Diseases Claimed to have Prevailed.

Scarlatina.—It has been claimed that epidemics of this disease have been experienced in Santiago and Valparaiso; and also others of

Measles.—If either has prevailed, it has no permanent abiding place; but depends for sustenance upon reimportation; while the visitations are mild and short-lived.

Relapsing Fever.—It has been stated that an epidemic of this peculiar disease visited the south Pacific coast in 1854, and spread from Perú to the northern parts of Chile. That the disease was the genuine relapsing fever, must be considered a doubtful question. So far as can now be learned, the malady resembled the malarious fevers, which constantly prevail in Perú. Relapsing fever is a singular disease, and has that element of periodicity, which suggests some resemblance, so far as the parts of the system upon which the impress of the virus is made, at least, to the ordinary malarial affections. The periodical feature of the disease is not the only point of resemblance to those of malarial character; but the enlargement of the spleen, which constitutes the single pathological change in relapsing fever, gives it another point of contact with the former affections.

As germane to our present subject, the fact may be here

recalled that Obermeier, in 1868, announced the finding of specimens of *spirillæ* in the blood of relapsing fever patients, which disappeared when the fever went off, and reappeared upon its return. This observation has been corroborated by others, but at best the fact has no more than a negative value, as will be shown hereafter.

Dengue.—This disease is reported to have prevailed in Perú as an epidemic in 1818, and again in 1852; upon both occasions as a precursor of yellow fever. The probabilities are that the visitation was an exaggerated type of malarious fever.

Yellow Fever and Cholera.—Both diseases are reported as having occurred in Perú, but never south of Callao. Both may have been transported by ship, but it is certain that no wide-spread epidemics have occurred even there; and that they have rapidly faded out with the first cases. These regions are so little known, and reliable observation of disease so little cultivated, that it is not safe to place much dependence upon general reports concerning epidemic visitations. An American official at Callao, was reported as having died, some twelve months since, of yellow fever, while there was no other case in the country. His real disease was glycosuria.

If it be admitted, however, that the above specified diseases of the acute infectious class have prevailed in certain localities upon the south Pacific coast, one fact must remain unchallenged, viz: that with the single exception of variola, no one of them has been of extensive and wide-spread prevalence, nor persistent among the people — the few epidemics which may have occurred, requiring as the starting focus a fresh importation of the particular disease. So far as regards the exception, variola, as it prevails in the region named, has lost its identity, so to speak, and has become almost a disease *sui generis*.

Non-Prevalent Infectious Diseases.

Cholera and Yellow Fever.—No case of either of these diseases has ever been seen between Cape Horn, and Callao, in Perú; and though both have been reported to have occurred at the latter place, yet there is certainly much doubt as to the genuine character of the visitations.

Scarlet Fever.—The disease may have occurred in certain localities, as reported; but it has no permanent abiding place in any part of the great belt under consideration.

Typhus Fever.—Never known.

Typhoid Fever.—The same.

Relapsing Fever.—The same, under the previously mentioned restriction.

Diphtheria.—Entirely unknown. The author has never been reliably informed of the existence of a case.

Cerebro-spinal Meningitis.—Entirely unknown in an epidemic form.

Hay Fever.—This very troublesome disease in certain and many parts of our own country, is an unheard of affection.

Mumps.—The author could not learn that this disease in its contagious form had ever existed.

Animal Poisons.

Reference has heretofore been made to the very curious fact of the native non-existence as a rule or law, of venomous reptiles, upon the western slope of the Andes, within the south temperate zone. This fact is well attested, and has a suggestive value in the consideration of our present subject.

Of the remarkable disease called *hydrophobia*, the author

believes himself justified in saying that it has never been known upon the whole coast. No physician with whom he conversed upon the subject, had ever seen a case, excepting one, who stated that dogs were sometimes affected with the disease, and would then bite people coming in their way; but that the human cases *were cured so promptly and easily* as to make it a thing of no serious importance.

CHAPTER IV.

A Glance at the North Pacific Coast.

It would form a valuable basis, for ætiological generalization, if the medical aspects of the whole north and south American Pacific coasts subjected to the peculiar physical conditions herein set forth, in their varying degrees, could be accurately and reliably mapped out. The writer has no personal experience with the Central American or Mexican coast. As directly bearing upon the subject, however, in connection with our own territory, he extracts the following quotations from the Report on Practical Medicine, made to the California State Medical Society at its meeting April 19, 1876, by Dr. Gibbons, a gentleman of national standing in the profession, and of more than twenty-five years' residence in that state.

Says Dr. Gibbons: "The absence of epidemics is worthy of note. Hitherto the epidemic tendency has been strangely wanting. In the autumn of 1850, and the ensuing summer, malignant cholera prevailed destructively in some localities. Several times since, it has been introduced in ships, and the subjects of it have been landed at San Francisco without restraint. But I am not aware that a single instance ever occurred in which it was even suspected to have been propagated. There have been several epidemics of small-pox, the last of which in 1870 was unusually violent and fatal; diphtheria, scarlatina, measles, pertussis have been constantly present here and there in a sporadic or endemic form; cerebro-spinal meningitis has

made a few alarming threats in remote localities, but speedily disappeared. . . . Conjoined with public epidemic diathesis, there seems to exist an absence of contagious activity in many of that class known as generally contagious. . . . Nor have scarlatina and diphtheria within the range of my observation exhibited that active power of communication generally attributed to them. By far the larger proportion of cases have been sporadic and isolated, though occurring in families of children where no provision was made against contagion."

The reader cannot fail to note the coincidences between the conditions as above reported by Dr. Gibbons, and those herein laid down as belonging to the same coast in the southern hemisphere. One significant fact must be borne in mind, viz: that there exist upon the southern continent, enormous mountain peaks which dwarf anything of the kind upon our own; and the earthquake energy is, therefore, more frequently displayed and vastly more violent in the former than in the latter regions of the world. Besides this, there are other conditions pertaining to the California coast, which, without doubt, have some effect in widening the similitude existing between the latter and the extreme southern Pacific coast. These arise in great part, from the configuration of the north Pacific coast toward the Northern seas; as also from the circumstance of the great Japan current of warm water, which in sweeping down bathes the California coast; both of these influences produce important modifications of the thermal, aqueous and electrical states of the last named coast.

Résumé.

In the foregoing pages the author has presented a mass of statements, which, if they be founded upon correct

observation, and the inference that the assumed exemption is due to peculiar physical conditions of the favored region, and not to the simple circumstance of isolation, be confirmed by future investigation, must certainly be possessed of no unimportant interest to the pathologist in his general as well as special investigations, concerning the intimate nature of morbid action.

Up to this point it has been his aim in the treatment of the medical questions involved herein, simply to bring out the salient features under the strongest possible light, but to avoid speculation upon them. It has been his effort to state the facts carefully, that subsequent observation might only tend to confirm them. If he has erred in any particular, therefore, it has resulted from inaccurate observation or misinformation upon the part of those, upon whom he was compelled, in many things, to rely. The facts are before the reader, who is now in position to draw his own deductions therefrom. His purpose, however, would be incomplete were these pages arrested at this point; or at least, without making an attempt to apply the facts previously narrated to a practical consideration of the general causes, and possible therapeutics of the acute infectious diseases.

PART IV.

THE PHYSICS OF SPECIFIC CAUSATION.

CHAPTER I.

Ideal Function of the Nervous System.

It has happened to every student in chemistry, during the course of pupilage, to try the experiment of thrusting the poles of a bar of magnetic iron into a mass of iron filings, and to have witnessed the curious architecture of the little needles as they hung themselves about the central force.

The animal organism is built upon the central nervous system. Each living molecule, as well as each of its atoms, however remote from the centre, holds its vital structure only so long as it remains within the influence of that principle, which physiologists have variously denominated the "vital force," the "nervous force," etc. Every physical and vital operation of the system, from the raising of a finger to the fabrication of the most complex solid or fluid structure, is performed under the immediate influence of this mysterious agency.

What is it? We have no more precise conception of its intimate nature, than we have of that wonderful power—that invisible and apparently insubstantial something, by which the stars are held in their courses. But, if we cannot develop causes, we may clearly recognize effects; and

it is very evident, that just as the sun is the central reservoir of energy for the planetary system about him, so is the *central nervous axis, the reservoir of that vital energy* through which our physical structure is maintained.

The recognition of an agency indefinitely called the "vital force," in explanation of the intricate phenomena of animal life, became an imperative necessity with the very earliest biologists. But it has always been deemed by the strict vitalists, a special and peculiar essence, entirely inaccessible, and wholly hidden under the mysterious secrets of the Creative Power. Is a nearer approach possible; can we see it even in shadow, or through a glass darkly? Strange questions, to be sure. But if it were in our power to approach it, only after the fashion that we have approached the one great energy of the universe, certainly we should derive a practical benefit from a knowledge of its established laws. To follow the subject in detail, would carry the present volume far beyond its prescribed limits; and therefore only those points can be touched upon having a relationship to our immediate line of inquiry.

Is the nerve force derived from *without*, or is it inherent *within* the human system? If we were to reply that it is both; that it must be derived from the original force of nature, because existence is impossible apart from that force, and that it must also be inherent in the sense that its manifestations are of a character peculiar, in many respects, to the economy, we should logically concede an affirmative to the first inquiry, because in such a statement the greater fact necessarily includes the less. This much, however, may be asserted, that the energic manifestations of animal life do not resemble, precisely, any form of physical energy with which we are acquainted. Its development has been roughly likened by some physiologists to the evolution of

electricity from a battery; and, perhaps, it could be termed, not inaptly, *vital electricity*, in order that a tangible something might be presented to the mind. The electric energy approaches it, indeed, in some of its results, as, for instance, when a muscle responds to the galvanic current; but while it is clearly apparent, that the two forms of energy are *not* identical, the similitudes are just sufficiently recognizable to show the same essential basis underlying all of the great facts of nature.

Vital Gravitation.

The point we are discussing is one of overshadowing importance; for in the consideration of the mysterious agency emanating from the nervous centres we are standing at the very threshold of the temple of life. We can go no further in our investigation, until we obtain some few lights, at least, to guide us through the labyrinths which now lie before us. The author has a full knowledge of the difficulties of position besetting the discussion of these questions; but, he, who seeks the truth should carry a well-set lance, and be prepared to ride his object down, regardless of impediment.

It has just been stated, that the animal organism is built upon the central nervous-axis. If we go deeply into the minutiæ of generation, and tabulate the results of all our investigations as to the make-up of the fertilized germ, which is destined to expansion into the animal life, we shall find them expressed by a *curved line* — a very small line to be sure; but it is the first marking of the future figure, from which, as a centre, every other must be drawn in order to complete the proportions of the developed object. This line covers our vision, as to the facts beneath it; but we have learned to recognize in the line itself the centre of some mysterious force, from which every atom of the future

structure is developed, as the leaves and branches of a tree are developed from the main stem. We cannot go *behind* the line, but we may follow it, until it has left the field of the microscope, and has become the *central nervous-axis* of the animal creature. If these statements pass unchallenged, then we are entitled to formulate a proposition to be embraced in these words: ANIMAL LIFE BEGINS IN THE CENTRAL NERVOUS-AXIS.

After all that has been said in these pages upon the general subject of *force,* it will be unnecessary to go into a discussion as to the nature of the force which has become an inherent of the small line spoken of. The author may remark, however, that the force itself is a derivative from the parents, and carries with it the features of the parentage; and thus it covers, not alone the facts of *heredity,* but also those of *distinct species.* And if we follow it back through all the ages of each particular existence, we shall at last arrive at the inevitable conclusion, that the factor, *force,* has worked out the problem of the ORIGIN OF SPECIES.

But this innate principle of the nervous-axis is as much of a *central fact,* so far as relates to the atomic organism which clusters about it, as is that of gravitation which holds the animal form to the surface of the planet. The author, then, proposes, as a designation of the force resident within the nervous-axis, appropriate until clearer ideas of all these subjects shall give us a better nomenclature, that of VITAL GRAVITATION.

We have been dealing with the thing itself, up to this point, and have taken no cognizance of its general manifestations. To cover the idea involved by the *force in action,* no better term than that of *vital energy* can be given to it; and thus we may have a condition of *plus* energy, and a condition of *minus* energy; we may have a *nor-*

mal energy and a *transmuted* energy; it may be motion here, and heat there; as we shall see further on.

If all the foregoing propositions be coined from the metal of truth, and be not the spurious issue of the mere imagination, then we have advanced immensely, not only in the study of our present subject, but toward a better understanding of many things. As we have formulated one law, we may now formulate another, as follows: ANIMAL EXISTENCE RESIDES, *de facto*, WITHIN THE CENTRAL NERVOUS-AXIS; *and the first inspiration of the fœtal being gives* INDEPENDENT *birth to a form of energy destined thenceforth to furnish the conditions of its own perpetuation within that particular economy, wherein the capital facts of life run in a circle without beginning or end, until the chain is broken by the hand of somatic death.*

Distribution of the Nervous Energy.

In the inquiry as to the method of distributing the influence which resides in the nervous-axis, to the various parts of the system which depend upon it for life, we have no difficulty in recognizing the nervous trunks and their ramifications as the channel through which this is accomplished. These are the wires connecting the central battery with the peripheral and way stations. All this is clear enough; but unfortunately, it is but the simple expression of a naked fact stripped of every vestige of detail. It must be the work of the future physiologist to supply the necessary garments.

When we speak of "nervous currents," "currents of nervous energy," etc., we express the idea of the actual flow of a certain entity, just as we do when we speak of "currents of electricity." As the representation of an ideal action, this is well enough; but as the statement of a fact,

it is a great fallacy. There is no more of an entity, or distinct thing, transmitted over the nerve-trunks, than there is transmitted when electricity "passes over" a wire. It is in both cases a *condition* of the medium or media of transmission, which we recognize — not a substantial entity.

Under such an interpretation we need be no more at a loss to understand why a spinal nerve with a common trunk, but having *two* roots, can transmit motor and sensory impressions at one and the same time, than we need be to comprehend the latest achievement of modern telegraphy, viz: how four distinct messages can be sent over the same wire at the same instant. We must imagine a nerve trunk and a common wire, as well as everything else in nature having *extension*, as being constituted of rows or strings of the atoms composing it, just as beads are strung together for an ornament. The thickness of a nerve trunk or of a wire is determined by the number of these atomic rows which it contains. One single row will transmit an impression in one direction, and its next neighbor will transmit an impression in the opposite direction, at the same instant. A *single* row of atoms will transmit, therefore, as perfect an impression as a million rows; but the difficulty is, that even were we able to isolate a single row of atoms, as we are not, nor a thousand of them, the impression conveyed would be too delicate for our realization, either by touch or vision. The capacity of a nerve trunk or a wire, to transmit impressions, which are palpable to our senses, is, hence, only limited in number by our own ability to take cognizance of them; or if we may express it in so quaint a manner, by the *size* of the impression itself. The time will come, probably, when not only four messages, but a dozen will be sent speeding simultaneously over the same telegraphic wire.

For the present we are compelled to express our ideas of the transmission of energy by the terms "currents," etc.

Having cleared away all these preliminaries, and come to an understanding as to terms of expression, etc., we have yet to touch upon another point, before we can make a further advance. It is one of the most important branches of the intricate problems we are studying. We may term it

The Localization of Energy.

Anatomy shows us that the nervous-axis is composed of two wholly different structures, the *gray* and *white* matters, respectively. The former is composed of the cell-element, and represents the seat of the higher functions of intellection and sensation; while the latter is composed of the fibrous or tubular structure representing motion and conduction.

This, as a general fact, is remarkable enough, but it is surpassed by the details of the nervous functions and processes. *Particular portions of the nervous-axis preside over particular functions and parts of the body.* This is a fact of quite general recognition, and is illustrated by the nerves of the special senses; by the functional operations which are invariably affected through the division of a particular nervous communication; by experiments upon the brain, as of that by Bernard, who excited the sugar-making process by irritating the floor of the fourth ventricle; by experiments upon the spinal cord, the sympathetic, etc.

The fact is susceptible of copious illustration and proof that every portion of the living body is presided over by a particular locality of the nervous-axis; and that in some inscrutable manner, parts which seem in no way related, anatomically, are grouped together by nervous influence; or, as the author elsewhere expresses it, *lie in the same circles of nervous energy.* The curiosities of various reflex

actions will at once suggest themselves as finding a ready explanation in this indisputable circumstance.

But we shall find in the fact something more practical than curious if we search for it. Whatever may be the nature of the central force resident within the nervous-axis we cannot know; but there lies before us a conclusion which we must accept, simply because there is no alternative. We are treading upon perilous ground, but it seems that we have none other upon which to stand. Just as it is a fact, that localization of the vital energy is at the bottom of differences of function, so it would appear to be a fact, also, that each anatomical part of the central nervous-axis, which presides over other parts and functions, *evolves a form of energy peculiar to the first mentioned part,* which latter may be called *a presiding- or function-centre,* as regards the part or function presided over.

If the localization of energy, called by late physiologists, localization of function, be a reality, then a form of energy *specific* to each anatomical locality, or perhaps, to each function-centre, is a foregone conclusion. The author believes both theories to be true; and in a subsequent work hopes to go into such details of these interesting topics as are prohibited in a work like the present. But upon the basis of a *specific* energy pertaining to each function-centre we may find the solution of some of the most inscrutable phenomena of life. The mysteries of heredity, whereby defects of constitution are transmitted to offspring, become easily understood. And further than this, the *origin of species,* a question heretofore shrouded in absolute darkness, may receive some intelligible interpretation upon the same basis.

The point which the author now desires to bring into prominence is, that the localization of energy, just spoken of, *conveys a characteristic impress upon those functions*

and portions of the body, which lie within a specific circle. From this fact it results that *type-diseases* are capable of production. Every such disease involves an implication of certain organs and functions. The organs may be remote from each other, and the functions diverse in character. But variola, scarlatina, etc., mean the constant implication of certain organs and functions — only this, and nothing more. The impress of the contagium is made upon a point or points of the nervous-axis, which comprehends within its presiding influence those particular organs and functions lying within its own circle.

In all these statements the author feels that he does not "theorize"; but is confident that he expresses many plain facts, a thousand proofs of which will at once suggest themselves to the observer, who has profited by study and experience. Further considerations under this head will be presented when we come to consider the immediate cause of the infectious diseases, in subsequent pages, and where the *circles of energy* will be more fully dwelt upon.

It will be then shown, also, that all diseased action in the human system is *molecular* in character, and that the alteration of the molecule depends entirely upon the *energy* behind it. Not to go further into the question at present, its mere mention is here made, in order that the two laws already announced may be supplemented by a third, viz: that ANIMAL EXISTENCE CEASES IN THE CENTRAL NERVOUS-AXIS. Our propositions will now be summarized by the statement, that *animal life begins, resides in, and is terminated by the central nervous-axis.*

In premising thus much upon the questions of the vital energy, we are in position to briefly consider those more immediately connected with our present inquiry; and especially to note the points of contact with, and features of resemblance between the "vital" and the "general" energies.

CHAPTER II.

The Source of Animal Heat.

Physiologists have now abandoned the original theory of Lavoisier, that the production of the normal animal heat takes place exclusively within the lungs, as a result of the chemical union therein of oxygen and carbon. Many still hold to the belief, that its evolution is the direct product of combustion within the circulatory round, and within the tissues themselves; and as regards the abnormal development of heat, the opinion of Virchow is the prevalent one, viz: "that elevation of temperature arises from an increased consumption of tissue—the latter effect appearing to have its cause in alterations of the nervous system"; though of what these alterations may consist, not even a conjecture is made.

While we are disposed to admit that the normal body heat is a product of the various processes involved in the functions of repair and waste, and in all organs of the system where the process of oxidation is going on; yet it seems impossible to accept these methods in exclusive explanation of the increased general temperature of fever, or the circumscribed heat-increase of a local inflammation. If it be urged in explication of the increased heat of fever, that the respiration is more rapid and combustion more active in consequence thereof, it must be answered, that the increased motion involved in fever, must of itself represent an antecedent energic condition which equally demands explanation; as it seems apparent that in such a statement

we have simply shifted the question from one point to another.

Insufficient to this extent, the theory utterly fails in explanation of the production of increased local heat with a normal respiration, and a tranquil action of the heart. To no greater degree will it suffice to account for the various thermal phenomena manifested after sections of the spinal cord, nerves, etc.; nor for the very interesting observations of Brown-Séquard, wherefrom it appears that pinching of the skin upon one side of the body diminishes heat in the corresponding member of the other side; and that by lowering the temperature of one side, we produce a lowering upon the other, with no notable depression of general heat. *Rubor et tumor, cum calore et dolore,* said Cullen in description of the phenomena of inflammation. Years of progress have hardly sufficed to supplement the terseness of this language, with a full and sufficient interpretation of all the essential factors of the process.

What then is the primary source of animal heat, and what are the contributing elements of the process? This would be a most interesting question to discuss at length, in an appropriate place. It will answer our present purpose, however, to assert, that the fulfillment of a function, so important to the animal existence as the equable and precise supply of heat, which is practically the same within the belt of the tropics, and the zones of the polar regions, cannot rest exclusively upon its production through the mere union of oxygen and carbon particles, in the reconstructive and degenerative processes of the system.

The whole function viewed in its normal as well as abnormal aspects, simply involves *energic transmutations;* but the *total energy* of the human system, is not at all measured by the metamorphic acts of repair and waste,

nor by the proximate *energic-capacities* of food elements, or the "working-power" they contain. These represent energy, which is, at once, active, or only waiting to become so — passive; kinetic, actual, or potential.

Behind it all lies a fact of stupendous moment, and one which the author has been steadily endeavoring to reach through all these remarks. A large portion of the oxygen which finds its way into the system through the lungs, and perhaps, to some extent, through that indispensable article, *water,* is carried through the circulation to the cerebro-spinal axis — the centre of that force, which the author has elsewhere denominated *Vital Gravitation — where by some occult action between the agent which acts, and the thing which is acted upon, there is evoked a form of energy, which constitutes the true vital energy, and by means of which all the operations of animal life are carried on.* We may think we see something parallel to this action in the chemical evolution of electricity from a battery; but whether we do, or do not, the potential fact remains the same; an invisible "current" begins to flow from the centre, which, in its course, is the current of life. It presides over every function, and sits at the feet of the king of the tabernacle. It is active, it is passive; it is actual, it is potential. Here it is accelerative, there inhibitory; here motion, there heat; here chemical affinity, there atomic polarity; here the action of day, and there the repose of night.

In the discussion of the physical forces, in a preceding portion of this volume, it has been claimed, as is now largely admitted, that there exists but a single, primitive force, and that every one of its known manifestations is but a transmutation of that original essence; that the body oxygen has a remarkable association with many of the manifestations of energy; and to carry the conclusion, *ad*

hoc, oxygen, as being so importantly concerned in these manifestations — it being equally impossible to burn a candle, in order to give us light; to inflame a pile of wood or coal, in order to furnish warmth, or consume the carbon particles within the system, in order to maintain the animal heat, without it — must be possessed of an inner character not yet revealed to the science of our time. However nearly these positions represent the real truth, the essential medical fact still confronts us, viz: that this body has a most profound and far-reaching importance to the human economy. To what extent or in what sense the fact relates to the infectious diseases, we shall inquire further on.

CHAPTER III.

The Theories of Specific Causation.

We now approach a consideration of one of the most difficult problems in the whole range of pathology — that which relates to the agencies operative in the production of a class of diseases, characterized by a distinct personality, so to speak, and with the power of indefinite type reproduction. The subject has engaged the attention of the most astute minds which have ever adorned the ranks of pathology; and although we are now in possession of greatly improved methods and appliances for successful investigation, the vital questions underlying the inquiry, still remain without satisfactory answer.

The author proposes a brief review of the now generally accepted theory, and an extension of the line of thought growing out of the physical considerations heretofore developed in these pages, in such direction as it seems naturally to lead. As a preface, however, to future observations, let us take a mere glance at a closely related subject.

The Order of Life in Nature.

In the light of well-settled principles, it is no unreasonable supposition, that certain physical conditions of the earth and air may be either promotive or destructive of certain forms of life; or that one chain of physical circumstance may call trooping into varied existence, forms of organization, which under a different chain would be utterly impossible. As proof of this fact we have but to

view the disposition of life upon our planet, in our own age. The fauna and flora of different sections of the world, are found to be widely diverse in character, as was first distinctly pointed out by Humboldt, in his Essay on the Geography of Plants, which philosopher erected Phytogeography into a separate science.

The learned Dr. Draper, of New York, in one of his delightful volumes,* has fully discussed the question as to how far man in his physical or corporeal attributes, is susceptible of modification under physical influences; and has adduced an imposing array of facts and arguments in support of his position, that man in many of his purely physical aspects, is largely the creature of climatic circumstance.

In relation to both animals and plants, we have but to look at the North and South American continents in order to realize the changes which nature works through her varied conditions. Nor can these depend, alone, upon differences of temperature; as lines of equal heat may be followed throughout the different sections of the globe, and local characteristics of animal and plant life still be found preserved. Nor yet can they depend, alone, upon mean or periodic amounts of humidity or rainfall; as localities thus related in a precisely similar manner, still maintain their distinctive characteristics of life-forms.

In extension of this analogy, let us step out of our legitimate path for a few moments, in order to take a hasty retrospect of a subject, which, while not essential to the convincing illustration of the principle above set forth, is nevertheless possessed of most fascinating interest to every student of nature; and as such has its interest, also, to the

* "Thoughts on the Future Civil Policy of America," by John William Draper, M.D., LL.D.

medical man. The remarkable progression of life upon our planet is here referred to.

The Fauna of Past Ages.

Passing the mysterious *azoic* age of the geologists, from which no voice reaches us proclaiming the existence of life during that epoch of the world's infancy, and reaching to those indelibly marked by its imprint, we find proofs of organized forms, which must have borne distinct relationship to the prevalent physical conditions of the planet. Nature's biography of existences, which have "strutted their brief hour upon the stage," and given place to others in succession, is a volume of astounding occurrences. From the small and curious *Eozoon* in the Laurentian series; through the Silurian, with its brachiopoda, encrinites and perfected trilobites; the Devonian, with its high order of fishes; the wonderful Carboniferous or age of stupendous vegetation, when the air must have been so loaded with carbon gases that no such animal as man could possibly have existed; and when the immense beds of coal, from which the world now draws its fuel supply, existed in a gaseous form in the atmosphere; the age of Reptiles, with its monster Saurians; the age of the great Mammals, with its mastodons and other enormous creatures; through the Ice-Period, up to the time when man, as the master-creation, came upon the earth, all alike tell the same strange story of special forms under special conditions.

The Flora of the Past.

Geologists tell us that there are indefinite markings of plant life as low down as the Silurian and Cambrian beds; but these were not much higher forms than mere sea-weeds, preceding the rich development of vegetable life

during the Devonian — that age rendered famous by Hugh Miller in his studies of the "Old Red Sandstone."

Up to the beginning of the Cretaceous period, the only known flora were pines, cycads and various forms of cryptogamic vegetation. At this time, however, a remarkable development occurs; *flowering* plants — the dicotyledonous — those higher forms of vegetable and plant life, have made their appearance. Along with this great change, marking another click in Nature's time-piece, comes hand-in-hand an almost incredible fact, viz: that many forms of tropical vegetation, as the myrtle, fig-tree, oleander, etc., flourished luxuriantly in that region now embraced under the name of Greenland, where natural vegetation, with the exception of the small forms of snow-lichens, is impossible.

Do these facts, so hastily detailed, bear any general principle, important in their application to the questions of disease-causation? The writer believes they do, and that it must be largely through the study of such questions that we shall at length be enabled to solve the causes of LOCALITY diseases — those, too, which have a double interest to us, as being, like an exotic plant, susceptible of extended transportation.

With these apparent digressions from the routine of medical discourse, let us proceed to the consideration of the two principal hypotheses of causation, in explanation of the infectious diseases.

CHAPTER IV.

Hypothesis of the Living Germ.

That very elementary forms of phyto-parasitic life exist abundantly in our atmosphere, as the germs and sporules of mould and other fungi; bacteria, vibriones, minute monads, etc. etc., is a fact easy of demonstration. Whether they, or any of them, constitute specific sources of disease; are simply the bearers of contagia, or destitute entirely of any agency in the premises, are questions now being hotly discussed by the investigators of all countries; and still remain, notwithstanding the volumes written upon them, without solution of a demonstrative and convincing character.

The doctrine of a living organism as the causative agent of an infectious disease — the *contagium vivum* — is not a new one to our generation, having been arrived at by the physicians of more than three centuries ago, in explanation of the well settled facts of the transmissibility and individual *specificity* of such diseases. Though a gradual decline in this opinion again took place, and the chemical, fermentative, or zymotic theory became the popular creed, yet the past decade, marked by improved methods of observation, and more extended and advanced collateral information, has witnessed the revival of the living-contagion theory, and its very large, not to say quite general acceptance.

The idea involved is still a very general one; neither the precise forms of particular organisms as causative of particular diseases, nor the *modus* by which they produce

their particular effects, having been definitely decided; except that as to the former, Hallier claims to have discovered a special type in connection with cholera, and Obermeier one in connection with relapsing fever.

The *schizomycetes*, so called because of their reproduction by fission, embrace bacteria and their broods as well as many low forms of life; but the word *bacteria* has become in relationship to these diseases, a generic term, embracing all of the varieties of phyto-atmospheric life, which may be supposed to operate in the direction indicated.

Objections to the Theory.

In approaching a consideration of the merits of this hypothesis, we are met at the very threshold of inquiry, by a perplexing question, closely related to the main one, and not to be avoided in its discussion.

With our established knowledge of the constant and omnipresent existence of these bacterial forms and their germs, in our atmosphere, it would seem a foregone conclusion, that as direct sources of specific disease, they should constantly operate in the specific channel; and as being vested with certain and definite results upon the human system, cause and effect should invariably be present, as well as apparent. The atmosphere constantly swarms with the germs of these very organisms supposed to be the direct causes of particular and special types of disease. This can easily be demonstrated by the simple experiment of preparing an infusion of turnip, or of any organic substance, and permitting it to stand exposed to the air for from two to six days; when upon placing a drop of the liquid under the microscope it will be found teeming with bacteria and other of the lowest forms of life, as compared with which latter, ordinary mildew stands high in the scale of organ-

ization. Indeed, the chief difficulty of experiment upon this subject lies in the effort to exclude germ particles from the air; and hence the necessity of filtration, calcination, etc., of that medium in order to obtain it pure and free of germ life.

It will not satisfy the spirit of logical inquiry, nor our conceptions of specific causation, to allege that at one particular time the cause is operative in one direction; at another time in another direction, and at another still, it is not operative at all. If a person be continuously exposed to the malarial poison, it is but a question of time and individual resistance as to when he shall succumb to its influence, which latter is always manifested in the same direction and by the same well known features. The malarial poison produces periodic fevers, and can no more set up in the system, the morbid action involved in scarlatina or variola, than can the union of four-footed animals produce a bird, or that of birds, a fish.

There seems but one escape for the bacterial hypothesis from the dreadful logic of "Plato's man," which lies in the assumption that *specific* bacterial forms are generated during the prevalence of specific diseases. This position is frail and hazardous, being beset by the whole question of spontaneous generation. The battle which long prevailed between the panspermists and the heterogenists still continues to some extent, and as relating to the fungoid organisms, we have the experiments and arguments of Pasteur in favor of the *omne vivum ex vivo* dogma, and those of Bastian in defense of *de novo* origin. To the writer it seems plain, that the well-known facts of generation go to demonstrate most conclusively, that not only does all life come from the living, but, also, that all life comes from life of a *similar* kind — nature very promptly arresting the lineal propagation of accidental or hybrid offspring.

But, in addition to such considerations, it does not appear that the bacterial hypothesis covers the facts and phenomena of specific disease-action; nor that any definite causal relation can be established. It is difficult, for instance, to explain the fact of the non-recurrence of certain of the infectious diseases by an influence wholly extraneous to the body. The ordinary conception of a "fermentative" action in the blood is not sound in face of the fact, that the blood is constantly being replenished by the processes of sanguification upon the basis of its normal constitution; and that the time must arrive when, as representative of its primitive state, it will be ready to reundergo the same fermentative change. If a permanent *molecular* change be alleged, then, of necessity, forces and actions specifically pertaining to the system itself are invoked, upon which it is quite as easy to found a causative conception as to non-recurrence, as upon the original bacterial impress.

Again: the theory is silent as to why such infectious diseases as chicken-pox, hooping cough, etc., should attack the blood of a *child*, and not that of an adult; why some of the infectious diseases are directly communicable, while some are not; why such a disease as cholera should only be perpetuated by a development of the poison *out* of the system, and why the fresh dejections containing, as they should, the causative agent, are powerless to transmit it. It does not of itself explain the great fact of hereditary transmission; nor can it give a satisfactory reason for the *periodic* features of such acute diseases as small pox, the entire fever of which disappears upon the appearance of the eruption; nor of relapsing fever, the febrile movement of which vanishes with clock-like regularity; the exacerbations of both to recur with unerring precision. One observer professes to have seen numerous specimens of *spirillæ* in the blood

of patients with the latter disease, while the fever was on; to have seen them disappear during the remission, and reappear upon the febrile return. We can have no conception of how causes apparently so accidental can be followed by effects so chronologically precise. The progressive development of progeny as the exciting cause of periodic action, is at entire variance with the circumstances and logic of the case.

And finally, as strongly refutative of the theory may be mentioned the well-known fact, that the various fluids of the infectious- or contagious-disease subject, are altogether the most powerful in the comparatively recent state, when there exist but few bacterial forms of life in them; and the least noxious, when sufficient time has elapsed to develop them in great numbers.

The Question of Fermentation.

Lately, the researches upon the process of fermentation, which appear to have developed vegetable organisms, as the exciting causes of that remarkable action, have been adduced as strong supports of the bacterial hypothesis. It must be remembered, however, that as yet, the results of these investigations are of the most conflicting character. The experiments of Pasteur have been more extended than those of any other observer. It is curious to follow his deductions as to the influence of oxygen upon the organisms, which he supposes to be causes of the various fermentations. It serves as a food for the ferment, and in a free state, it retards or prevents fermentation; it kills the butyric vibriones supposed to cause butyric fermentation, and it brings about acetic fermentation of alcohol, which is supposed to be caused by *mycoderma aceti*.*

* See the articles of M. Pasteur on Alcoholic Fermentation, in *Ann. de Chimie et Physique; Études sur le Vin, Compt. Rend. de l'Acad. des Sciences; On Yeast, Bullet. Soc. Chimique*, etc.

That not only vegetable, but also animal cells, under favoring conditions, have the power of setting up fermentation, is beyond doubt; but whether the vegetable organisms observed in connection with the ordinary fermentations by Pasteur and others, are the prime agents or simply incidents of the process, is still an open question. Pasteur's experiments are defective, in that the fermentative processes were not observed in calcined air, to the end that no organic germs other than those contained in a given quantity of the ferment might complicate the process.

The following considerations, as it seems to the author, militate against Pasteur's conclusions as to the various fermentations being caused by broods of special vegetable organisms. The soluble ferments of the body, as ptyalin and pepsin, are competent, through their vital endowments, to produce metamorphosis in certain bodies, as that of starch into sugar, etc. The fermentative action of diastase upon starch which results in the production of sugar, is precisely imitated by the action of dilute boiling sulphuric acid upon starch. These facts show that one variety of molecular transformation, which as truly represents a "fermentation," as does the subsequent progress of sugar into alcohol, carbon dioxide, succinic acid and glycerine, occurs apart from the development of special vegetable organisms.

But there exists another militant circumstance more directly bearing upon the subject, which is to be found in the rapid effect of free electricity upon fresh milk and other substances containing sugar. It is well known to dairymaids, that a thunder-storm will "clabber" milk in a very short time after being drawn from the cow. In other words, the milk will become sour from the development of lactic acid, which latter quickly coagulates the casein. The conversion of sugar into lactic acid is a very simple process,

and only involves a splitting of the sugar molecule according to the following formula:

Sugar. Lactic Acid.

$$C_6H_{12}O_6 = 2C_3H_6O_3$$

A similar illustration may also be mentioned in this place. The article called *mead* is a very common and highly esteemed summer beverage. It is prepared by subjecting honey or sugar in solution, to the alcoholic fermentation, by the addition of yeast. Usually, from thirty-six to forty-eight hours are required to bring about the process, and to render the liquid ready for use. But the makers of it well know, that a sudden thunder-storm will "sour" it over night, the alcoholic fermentation being set aside, and the lactic developed.

Now, the change by which the decomposition of the sugar molecule in both cases, is brought about, begins immediately upon a sufficient manifestation of the electric energy in the atmosphere, which need not be of very pronounced character; and the whole process of conversion, including the coagulation of the casein, in the case of the milk, is completed in a very short time,—frequently not exceeding a few hours. The author need not dwell upon the evidence furnished by the foregoing facts, and must leave them for reconciliation or explanation, to those who advocate the doctrine of special microphytic ferments.

These considerations, however, with others, which might be adduced, render the author unwilling to accept the full conclusions of Pasteur's school regarding the precise agencies of fermentation. Nay, the older doctrine of *catalytic* action, so ably defended by Liebig, cannot be said to be overthrown as yet. According to him "the cause of fermentation is the internal molecular motion, which a body in the course of decomposition, communicates to other matter in which the elements are connected by a very feeble affinity."

The whole subject has a much closer relationship to the class of infectious diseases in particular, than is generally realized; and its study is capable of producing most substantial results in the interest of disease-causation.

Prevalence of Atmospheric Germs.

As to germs of organic life, the atmosphere, under ordinary conditions, swarms with them; this is readily seen by allowing a beam of light to enter a darkened room, when the little particles of dust constantly in motion, and undoubtedly containing a large percentage of organic germs, become visible. But these particles, numerous as they are, and only apparent to the naked eye under the circumstances mentioned, as we have every reason to believe, are very mammoths in size as compared to the infinitesimal creations, which the human eye will probably never see, in shadow or in substance. The following description by Pascal, cannot be considered entirely poetical, in view of recent developments in this direction: "Let man investigate the smallest things of all he knows; let this dot of an insect, for instance, exhibit to him in its diminutive body parts incomparably more diminutive, jointed limbs, veins in those limbs, blood in those veins, in that blood humors, and drops within those humors—let him still subdividing these finest points, exhaust his power of conception, and let the minutest object his fancy can shape be that one of which we are now speaking—he may, perhaps, suppose that to be the extreme of minuteness in Nature. I will make him discover yet a new abyss within it. I will draw for him not merely the visible universe, but all besides that his imagination can grasp, the immensity of Nature, within the confines of that imperceptible atom." Nor this of Tyndall: "There exist in the atmosphere, particles of matter which elude the

microscope and the scales, which do not disturb its clearness, and yet are present in it in so immense a multitude that the Hebrew hyperbole of the number of grains of sand on the seashore becomes comparatively unmeaning."

Conclusions as to the Bacterial Hypothesis.

The summing up of the author's views upon the bacterial hypothesis, may be stated in some such form as the following:

Is it probable that the human body may be affected by particulæ of greater or less proportions, and organic or inorganic in nature, contained in the surrounding media?

Undoubtedly. We have conclusive evidence upon the point; not only in recognized parasitic diseases, but in the malarial poison, which, as susceptible of being barred off by mechanical obstructions, is presented to our minds in the form of a substantial entity, however infinitesimal in character it may be.

Is it not a fair inference, then, that the infectious diseases are caused by the bacterial germs, as now so largely claimed?

In face of the negative character of all the testimony alleged in favor of such a theory, and the positive nature of that against it, the inference cannot be a fair one.

Under what circumstances or conditions are these bacterial germs developed?

This question involves a wide discussion of the laws governing vitalized matter, and a general proposition concerning it will be stated further on. At present, we may say, that these organisms are now known to be developed in connection with animal or vegetable decomposition; or, in other words, when the vital energy, which gives to bodies over which it presides a complex molecular organization, is

no longer operative; and when, therefore, the general forces of nature begin the work of bringing the vital molecule into immediate subordination to its own laws, whereby it is resolved into more elementary combinations, these micro-organisms find pabulum for development, which their feeble organizations could not extract from living compounds. Hence, they are found in the healthy human body in connection with retrograde metamorphosis of tissue, as for instance upon mucous surfaces with their effete débris; in diseased states in general; in connection with pus formation; with adventitious deposits; with the effete products of febrile action, etc. etc. They are likewise contained in much of the food and drink which we take.

All of the foregoing considerations seem to justify the conclusion, that the bacterial hypothesis cannot be founded in truth, because, first: The germs believed to produce the infectious diseases are constantly present in the atmosphere, in non-epidemic, as well as in epidemic seasons; second: The non-transportable, endemic infectious diseases — those not personally communicable — of which the malarial fevers may be adduced as a type, prove, so far as one fact may prove a general law, that specific disease-poisons *belong only to certain localities and conditions;* and hence, third: Those infectious diseases capable of exotic transplantation into unindigenous sections of the globe, must be rendered so, through the fabrication of a virus *by the affected system itself.*

CHAPTER V.

Hypothesis of the Contagious Bioplast.

Dr. Lionel S. Beale has advanced another hypothesis, behind which, undoubtedly, there lies some truth, and which may be briefly stated as follows. Dr. Beale assumes the existence of an original plastic or germinal matter, as the basis of all organized life, which matter he terms *bioplasm*, and maintains its distinctness from the original matter of Huxley, called by the latter *protoplasm*. The pus corpuscle formed in inflammation is but a form of bioplasm; and ordinary pus can be generated by simply increasing the nutritive pabulum of any ordinary elementary part. Under specific conditions not yet known, a pus with peculiar and specific properties or powers is formed, and the *contagious bioplast* is generated. In this manner the specific influence is constituted, and there is no actual necessity of a *preceding specific* influence, but the contagious influence should be capable of spontaneous production. Dr. Beale maintains that the specific contagium, like pus, has originally descended from some form of normal bioplasm.

The contagious bioplast is susceptible of transportation, and of entering the system of another, where it grows by multiplication during the incubatory stage, until the whole system is infected, and the original disease produced.

The details of this theory are quite incomplete, and in many particulars, unsatisfactory. One of its essential weaknesses lies in the assumption of a possible *spontaneous*

production of the contagious bioplast; or, in other words, that a purely specific disease may arise *de novo*. This assumption is negatived by everything we know regarding this class of diseases; and any theory which seeks to dispense with an antecedent parentage manifestly leaves out of the problem its principal factor.

CHAPTER VI.

Hypothesis of the Infectious Molecule.

With a view to arrive at some practical conclusions, from the facts and arguments heretofore adduced in this volume, let us consider the acute infectious diseases, first, *as to their origin;* and second, *as to their mode of propagation.*

Origin of the Infectious Diseases.

That certain of the infectious diseases are caused by a positive entity, too minute in character to have been recognized as yet, we have convincing proof; as, for instance, in the poison of the malarious diseases, which may be intercepted by mechanical obstructions. In this case, there exists a specific-disease influence, occurring in certain localities and under certain conditions; and always producing a typical disease in those whom it affects. Against these premises, there can be no valid exception. Hitherto we have been led to regard this poison as of vegetable character, and in view of Dr. Salisbury's claim that he had found the producing agent in the palmellæ, it seemed as substantial in character as are the present supposed infecting bacteria. But we have no proof that this poison may not be of animalcular nature, as we have none that the whole class of original infection-disease producers, may not be of that constitution.

Perhaps one of the most remarkable developments relating to this subject, is that of the *Verrugas Fever,* heretofore spoken of in these pages. The locality which gave special

birth to this fever, or, at all events, which gave it notice and prominence, was at an altitude of nearly 6,000 feet above the sea, in an arid and rainless region, where a few characteristic cacti represent the scanty flora. Water tumbles, at certain periods, through a deep chasm spanned by the Verruga bridge, 262 feet below the track level. It was upon breaking ground in this particular place, that the poison of this peculiar disease was let loose; gathered its victims; lived for a season only; vanished and left no sign, except in its heritage to the sufferers from its attacks. All of the circumstances of occurrence, locality and physical surroundings, point to the belief, that the poison consisted, rather of minute animal than of vegetable life.

An Original Habitat.

But the principle represented by that great truth of nature, so copiously illustrated in the preceding pages, viz: that special organic forms exist under special conditions, must now be considered in its direct application to our subject.

Every organized existence has its *original habitat* or habitats — the place or places whence it started — the locality to which it is indigenous, by reason of the prevalence of those general conditions which render its existence possible. This must be as true of the entities which originally produce the infectious diseases, as it is of any of the high forms of organic life. Malarial diseases, for example, are generated in a certain locality, differing in no sensible characteristic from another, which is entirely exempt from the influence. The *Chabalongo*, or typhoid fever of Chile is a special type, indigenous to certain parts only, of that country; while the *Verrugas* of Perú, sprang from a circumscribed spot, where probably no human foot had before

trodden. Other locality diseases will be mentioned presently.

While the correctness of these observations so far as the so-called miasmatic order of infectious diseases are concerned, must be at once, admitted, it will be readily perceived that the class of *transportable* diseases, represented by cholera, the home of this latter in India, being fixed beyond dispute, fall within the same laws.

All of the infectious diseases, undoubtedly, possess an original *habitat*, where it is probable they are now, as always, capable of spontaneous origin, in their *primitive form*, whatever that may be. The difficulty of tracing disease-types through various localities, and among different peoples of the globe, have up to this time prevented a precise knowledge upon the point, which time may yet bring us. It seems tolerably certain, however, that the several acute infectious diseases named below have the nativities here attributed to them.

The Cholera.—Has its home in India.

The Small-pox.—In the East. Known in China nearly 1200 years before Christ.

The Plague.—An Oriental disease. Has a distinct geographical range.

The Typhus Fever.—Ireland its birthplace.

The Typhoid and Relapsing Fevers.—Have fixed centres in Ireland, Galicia, Upper Silesia, and some provinces of northern Italy.

The Miliary Fever.—Is endemic in a few provinces of France, Germany and Italy.

Scarlatina.—Probably native to Arabia.

Epidemic Dysentery.—Home in the tropics.

The Dengue.—In southern latitudes, with sharp geographical limits.

The Yellow Fever.—Distinctly traced to the Antilles.

The Chabalongo.—Chile.

The Verruga.—Perú.

In this connection may be mentioned the claim of Hallier, the professor at Jena, who has devoted much attention to microphytology, and who has *cultivated* many of the supposed microphytes of infection, that the natural home of all *penicillum-bearing* fungi, is Asia. However this may be, the already established facts bearing upon the subject of *locality* in connection with specific diseases, represent a principle of broad application; and is destined greatly to extend the present list of specific diseases. It is not difficult to believe, that the particular conditions of certain climates considered in the enlarged sense of embracing all of the telluric and aërial events and circumstances, in their connection with *sewer gas*, may call into development some individual influence, carrying with it a *specific* impress upon the human system. Of this nature, certainly, is the poison producing the *Chabalongo* of Chile, as it probably was of that lying behind the old "National Hotel disease" at Washington. Upon the same basis, the author has learned to regard the production of *phthisis pulmonalis* as due to a *specific* influence, developed under precise conditions pertaining to particular localities. Certain it seems, that no general influences of exposure or even bad hygienic surroundings, will establish the typical disease away from its local habitats, except through the penalties of heredity.

As to the intimate nature of the contagia which give native origin to the specific diseases, we are without any certain knowledge whatever. We may believe them to be of animal or of vegetable character; and that they may directly belong to the earth or air, or indirectly proceed from the lower animal creation. And notwithstanding the

claim of chemistry to the contrary, the writer is not wholly prepared to believe in the impossibility of a *gaseous* molecule, as representative of a toxic energy, susceptible of *specific* impress upon the system. Whatever the nature of these specific agents, however, one thing seems quite certain; that, as in the case of the malarial poison, the infecting molecule is infinitely more microscopic in dimensions than the phyto-organisms classed under the general term *bacteria*.

Their Mode of Propagation.

Only those of the acute diseases herein designated as "transportable," fall under consideration in this place. But two methods of transportation are possible; first, by means of the original virus or its progeny; and second, by the transfer of its representative results in the system. The author has already stated his inability to accept the first explanation, and is necessarily driven to the second. Upon what basis, then, may such an idea rest?

Vital Polarity.

In considering this question, the conclusions of the preceding pages must be constantly borne in mind. It has been stated, that the central nervous axis is the true repository of the vital force, and that the whole material structure of the body is built upon it. This implies not only force in general, for structural organization and make-up, but likewise, *force in detail* for functional activity. Each atom of the human body possesses what may be called a *vital polarity;* and the precise atomic constitution or arrangement of each molecule of any particular tissue, represents the *aggregate* polarity of all the atoms composing it. The organic, like the inorganic molecule, represents the ultimate division of matter, to the point where the quali-

ties of the substance still inhere. Beyond that point, of course, we destroy the substance, and resolve it back to its atomic elements. The organic molecule, though never having been handled like the inorganic, is, nevertheless, as much of a verity; and if we wish to deal intelligently with the maladies of the human body, we must approach it, in its atomic and molecular make-up, just as the chemist has done with the bodies falling under his scrutiny.

The Organic Molecule.

It results from this basis of construction, that the human body in ideal health, has a very typical molecular constitution, which remains intact just so long as the normal energy is equably supplied, so to express it; and the molecular polarity is undisturbed. The molecule of the human body has an atomic arrangement so very complex, that we may readily generalize a proposition maintaining, that the higher the nervous organization of an animal (apart from all considerations of mind), the more complex the composition of the molecule. As an instance let us cite the following formula of albumen as proposed by Lieberkuhn:

$$C_{72}H_{112}N_{18}SO_{22}.$$

When we attempt to construct the arrangement of the albumen molecule out of such a formula, so as to satisfy the polar affinities, or in chemical language, the quantivalence, of all its atoms, we realize what an intricate mechanism we are studying.

Now, there is nothing, whatever, theoretical in these considerations pertaining to organic structure; but just as certainly as that inorganic bodies are built up of molecules, which assume the relative situations *demanded by their polar forces,* and thus give form to the particular body, just so certainly is the organic body constructed

upon similar principles; the notable difference being, that in the inorganic world, the energy animating the particles of matter is derived *directly* from the forces of nature; while with the organic particles, it is an *indirect* derivative, through the structure of the organism itself.

Here the author places himself in direct antagonism to those ultra-chemists who maintain, that there is nothing peculiar in organic chemistry, and that its actions are subject to the same laws as those governing inorganic matter; and who attempt the proof of the correctness of this view, by their ability to construct some compounds belonging to the animal body, outside of the operation of its peculiar laws. This claim is partly true and partly erroneous; true, in so far as it relates to an essential principle governing every atom in the universe; and erroneous, in so far as it relates to the specific energy of particular things, or forms of matter.

The Vital Chemistry.

The whole animal system is primarily made up of inorganic elements; and some of its compounds, as phosphate of lime, for example, are the same substances in the organic and in the inorganic worlds. The laws of chemical affinity, as displayed in the laboratory, may be operative, therefore, *within* the animal to the extent that the most radical inorganic chemistry may claim. But vital chemistry rises above the circumstance, that carbon has a strong affinity for oxygen; chlorine for hydrogen, etc.; and taking a certain number of atoms of carbon, nitrogen, oxygen and hydrogen, forms, perhaps a molecule of fibrous tissue; or perhaps a molecule of cutaneous tissue; or perhaps a molecule of cellular tissue, etc. etc. There is, apparently, no limit to the diversity of combination in the high organic molecule. Its peculiar features nowhere pertain in the inorganic world, as the

force or energy which determines it, is exclusively resident within the vital economy.

Though the chemist, by analysis, may tell us the constituent atoms of certain products of the living being; and though he may be able, even, to reconstruct or produce some simple forms in his laboratory, yet his unimportant results in this direction only prove the existence of a force presiding over the methods of vital chemistry, which render him impotent to construct such eminently vital products as urea; not to speak of the characteristic structures of a healthy body, as muscle, flesh, blood, nerve; nor the products of disease, as pus, etc. No sensible person expects the accomplishment of such things, of course; but the ultra claims of some chemists logically involve this, and nothing less.

The distinction, then, is broad and apparent; and under this interpretation, the observations of the author upon the vital chemistry in health and in disease, must be understood.

Molecular Nature of Disease.

But to return. Every diseased action of the system, be it great or be it small — not purely of a functional character (and it is questionable how far even this class of morbid action may not be so) — involves a disturbance of the individual molecular energy; and *to just the extent of diseased structural action, is the extent of departure from the normal molecular constitution.* Hence, all morbid movements have this precise signification.

The Energic Nerve-Circles.

Let us consider what appears to be another fact. Every atom of the body is mapped out, so to speak, by its nervous energy, which it directly or indirectly receives from a special

centre of nerve force. This is arranged upon the plan of a general grouping of particular parts, receiving energy from the same centre; or, in other language, every portion of the body is traversed by currents of vital energy, which give to each integral part of the economy, a *magnetic meridian* — if it be permissible to borrow an expression from the nomenclature, and an illustration from the domain, of pure physics — all of which currents are subordinate to, and regulated by, a special centre of the nervous-axis, from which particular functions are derived.

Energic Groupings.

What may be the precise plan of this grouping, whether relating to function or structure, or both, we do not know; but the facts of physiology demonstrate its verity beyond a doubt. Hence it results, that specific causes operating against the integrity of the system, are *immediately* operative within the limits of the energic nerve-circle above spoken of. A little reflection must also demonstrate the truth of this proposition. Consider the *modus operandi* of medicines for a moment. The precise energy involved in the constitution of a molecule of croton oil, will carry its effects straight to that centre which presides over the nervous supply of the bowels; and a few drops, only, produce irritation, griping or purging, and frequently all of them; and this, too, whether applied to the tongue or introduced into the stomach. Opium, whether placed under the skin, within the rectum or into the stomach, goes as soon as permitted by absorption, to the same portion of the nervous-axis, and produces its characteristic effects. A molecule of hydrocyanic acid represents an energy so potent, and its affinities lie toward a portion of the nervous-axis so extremely vital, that it becomes, as is well known, one of the most deadly of poisons.

Grouping of Morbid Actions.

The same facts are taught us by the various morbid actions of the body. Every such morbid action is susceptible of special classification, though as yet we have only learned to make classifications in a general way. We have observed, for instance, that a certain morbid process results in various symptoms, among which is a perfectly characteristic eruption upon the skin; and we call the disease involved in the process — small-pox. There is no accident about any of its features, however. The variola pustule is always one and the same thing, as are the accompanying symptoms; and we should, indeed, be illogical, if we failed to infer from the facts, a precise and specific cause, acting upon a precise and specific part of the energic-axis, presiding over those involved in the variola movement.

In the infectious diseases, we have a very forcible illustration in that curious affection, *epidemic mumps*, which in its progress may suddenly leave its original seat, and locate itself in certain parts of either the male or female reproductive system. We can only wonder as to the relationship between parts apparently so dissimilar; and yet, there is never a mischance about it; if metastasis occur, it is, invariably, to the same set of organs. A like principle is illustrated by erysipelas when transferred to the brain or puerperal uterus; as well as by rheumatism in its transmigrations among the fibrous structures. In all these cases we have to deal primarily, not with swelled glands, diffuse tissue inflammations, or painful joints, but with the *aberrant energy*, which suffers molecular disturbances at the circumference of the circle.

It is a difficult thing in treating of subjects so vast and suggestive, to keep one's self within the narrow bounds pre-

scribed for so small a volume as the present; and the mere statement in outline, of the foregoing views of vital force and structure, must serve to introduce what the writer believes to be, at least an approach to, the true theory of the infectious diseases.

Poison-Centres.

We cannot evade the conclusion, that certain morbid agencies, of whose intimate nature we have not the remotest conception, may produce disease in the human system. Simple observation teaches us this; as also that certain diseases are produced very constantly in connection with certain influences. The most typical illustration we can adduce of this fact, lies in the often cited case of the malarial poison, which pathologists have designated as a miasm. Observation also shows us, that *all* of the infectious diseases proceed, directly or indirectly, from certain poison-centres, just as distinct as the poison-centres of malaria. There can be no dispute as to these facts. As before remarked, we may imagine the poison to be organic in nature, and to that extent may adopt a "living germ theory." If we could stop here, all were well; but unfortunately, we cannot. As man had an advent upon the earth, so the infectious diseases had an advent among men. General analogies, which have been briefly traced in these pages, teach us that man is the only organism of a truly cosmopolitan character, either in present or past existence; that descending to particulars, as applied to our subject, as special forms of life are indigenous to special conditions, so disease-centres are sharply defined, and operate only within their own narrow limits. The malarial poison-centres are here adduced in illustration.

How is Transportation Accomplished?

From these reflections, it must be apparent, that the perplexing feature of the infectious diseases, is their *transportable* character. If a certain disease be the result of a local poison; and that poison, itself, be not susceptible of transportation, either through the air, or by germ reproduction in a diseased body, how can the disease be sown broadcast, away from its home?

It has been previously maintained, that every purely nonfunctional disease-action, represents *a molecular change of structure.* Though it is now claimed that a pus-corpuscle is only a colorless "migrated blood-corpuscle," yet, if it be that, it is also, *something more;* it is a molecule *altered in its atomic structure,* either by metathetic action, or what is more probable, perhaps, by a *rearrangement* of the original atoms. This alteration, whatever consisting in, *represents the specific energic-action by which it is brought about;* and the atomic constitution of the molecule, under general physical as well as vital laws, *disposes it to alter, in conformity with its own energic character, any other molecule brought with niits influence.* It may be roughly likened to a magnet, which polarizes all masses of iron in its own vicinity in accordance with its own polarity; or to the prime conductor of an electrical machine; and as applied to fluids, it has a catalytic power capable of producing an action, which, whether we call it "fermentative" or what not, results in the same thing, viz: either a positive splitting of the contiguous molecule, or an atomic rearrangement.

The Inorganic Molecule.

Just as a molecule of hydrocyanic acid represents in its atomic arrangement, the specific energy determining it, so

a molecule of the virus of a mad animal represents the atomic construction imparted to it by the force which called it into existence; just as a molecule of healthy structure possesses the atomic make-up required by the normal energy which lies behind its creation, so a molecule resulting from diseased action represents the energic condition which evoked it; and just as the cell of a "ferment" possesses an energic construction of its molecule, which represents the antecedent action giving it birth, and is therefore capable of imparting the action which must result in a progeny of similar molecules, so the molecule of a diseased action in the human body possesses that representative energic condition, capable of being imparted to contiguous molecules, of different structure.

The Infectious Molecule.

If these premises be admitted, then it is easy to recognize, as a result of the morbid movement involved in the separate infectious diseases, the birth of an *infectious molecule, which shall be scrupulously representative in its atomic arrangement, of the parent movement which evolved it.* Upon this basis, may be explained more or less satisfactorily, every phenomenon connected with these singular diseases and their peripatetic characters.

In dealing with the healthy living molecule, we must remember that it is not a simple, inorganic construction, but one of great complexity, which character it holds just so long as it is subjected to the normal influences of its existence. But when disturbing conditions occur, involving its energic relations, the whole molecule is changed. These conditions may involve a general or local excess of energic action, as in acute inflammation, which latter has for one of its results, that grouping of the atoms, which

constitutes the pus-molecule; or it may involve general or local deficiency of energic action, the extreme of which, is represented by molecular death as organized structure, and a return to the sphere of inorganic matter.

The Pus-Molecule.

The precise methods by which alterations of the normal energy, either of general or local character, apart from those of structural change in the central nervous-axis, may be induced, will suggest themselves to the reader. There may be general depression of energy as the sequence of bad health-conditions; bad air; bad and insufficient food; insalubrious residence; intemperate living, particularly as to certain stimulants, which, while accelerating motion and thereby temporarily exalting energy, are sure to result in subsequent depression. A familiar example of the part "energy" plays in altering molecular structure, is presented to us in the household method of bringing "a gathering to a head," by the application of sustained heat. Upon simple physical principles, the excessive heat-energy imparts increased molecular motion in the part affected, which increased motion supplies the whole basis for atomic change; and the pus-molecule emerges from the crucible, in advance of the time otherwise required by the morbid action, destined to evolve it. The author may remark, *en passant*, that while he is not prepared to assert dogmatically, that the formation of pus can only ensue from accelerated movement, he certainly entertains that belief.

Atomic Arrangement and Isomerism.

To Liebig belongs the credit of first recognizing the truth, that a particular *grouping of atoms* is capable of giving form and character to a substance. Modern chemistry

has confirmed this observation, and in those bodies called *isomeric* — the list of which seems constantly increasing — we have a convincing illustration how, for instance, simple *rearrangement of atoms* may convert a molecule of living tissue into a molecule of pus.

The modern chemist has been astonished to find that butyric acid and acetic ether, two widely different bodies in appearance, have precisely the same chemical formula, $C_4H_8O_2$; and he can only account for the circumstance upon the fact above stated, that the structure and character of a body depend wholly upon the particular *form* in which its atoms are arranged to make up the molecule. But there are other instances, which even more strongly represent the principle spoken of, and of these certain of the sugars may be cited. Some of these bodies have an identical atomic constitution, and by every visible feature, are precisely similar substances; and still, by the different directions in which they turn the plane of polarized light, we are brought face to face with the surprising fact, that in the ultimate molecule they have a different, though to us an inexplicable make-up.

In the present state of our knowledge, we can only account for these phenomena upon the principle above alluded to, viz: that *particular groupings of the same atoms will produce entirely different compounds.* This grouping, of necessity, relates to the *polarity* of the atom; and polarity simply represents a *certain form of energy.* In case of the inorganic atom, the polarity is derived *directly* from the primitive essence or energy of nature; in case of the vital atom, *indirectly* through the vital energy which immediately presides over it; and which imparts to it what in these pages has been designated as its *vital polarity* or vital chemism. It seems to the author, as though the logic of the facts, admits but this single conclusion.

The infectious molecule, then, being a creature of energic mutation, carries with it a *representative polarity*, which gives to it the infecting — shall we call it the *fermentative* — power; which power inheres to the molecule until other forces break it up or rearrange its atoms.

All Diseases are Infectious.

But, it may be asked, if this be the case, why is not every known disease infectious in character? To this it may be replied that, in a certain sense and within certain limits, undoubtedly it is so; though the ability to reproduce a specific or type disease depends, probably, upon two circumstances. Firstly, the particular part of the central nerve-axis toward or upon which, the action of the infecting molecule lies. This has reference to the extent and importance of the "energic circles" presided over by that particular portion of the central axis, whereby a number of very important factors are involved; as extent of disease, character of functions implicated, the plus or minus activity of the morbid movement, which implies a greater or less energic potency, in determination of the particular atomic grouping of the molecule of the resulting disease-product. Secondly, though perhaps to a vastly less degree, the particular *locality of the body*, whereon the climax of the morbid movement is expressed; it being a peculiar circumstance, that apart from the diseases produced by direct insertion of a specific virus (as that of rabies, of serpents, etc.), the affections which fabricate a contagium upon the *external* surfaces of the body, including the respiratory passages, as the eruptive fevers, etc., are, as a rule, the most infectious; while those elaborated *within* the body, or finding outlet through the intestinal canal, are least so. This marked difference seems to relate to the facility with which

the infectious molecule is given to the atmosphere; that of small-pox, for example, being thrown directly upon the air, while that of cholera finds exit through the bowels, and if it escape decomposition in its outward passage, must subsequently be liberated from the liquids holding it in solution, before it can mount the air and carry infection in its course.

Dissecting Wounds.

That all morbid processes, involving structural change, or the fabrication of disease-products, are inimical to the healthy organism, can be abundantly shown. It is well known to every medical man, that dissecting wounds are greatly more virulent in the very *recent* subject, while the cadaver more nearly represents the molecular constitution of the body at dissolution, than at a later period, when decomposition begins to resolve the complex molecule into simpler forms; and further, when putrefaction has fully set in, a dissecting wound has comparatively lost its danger. These observations apply to the body of one dying from disease; but in the case of an entirely healthy person suddenly killed by violence, as from a stab or pistol shot, a post-mortem wound has no specific effect. These are facts of significance in this connection.

Transfer of Non-Specific Infection.

Further: though in the nature of things, no directly-determining experiments can be made upon the healthy human subject, as to the noxious character of non-specific disease-products, yet the medical man frequently learns by experience, the effects of morbid matters upon his own person, as well as the dangers of conveying what may be termed non-specific infection, to others upon his instruments, etc.

Action of the Infectious Molecule.

To return, however, to the infectious molecule. What is its action upon the system — is it local or general? It is both. Just as an organic cell placed in a solution of sugar imparts its own representative energy to the sugar molecule, whereby atomic disturbance is communicated to the contiguous molecule, which in its turn communicates the disturbance to the adjoining molecule until the whole mass participates in it, so the infectious molecule when introduced into the body begins that mysterious action, whereby molecule after molecule of similar structure is generated, until their numbers are sufficient to affect the nervous-axis in that portion, which presides over the activities concerned in the particular morbid movement; after which the type action is set up by the nervous centre itself, resulting in the general climax, whereby the specific contagium is fabricated anew.

How this comes about in detail, cannot be determined until we know more of the intricate nature of the vital processes. When we are in position to comprehend in what manner, with the four elements, carbon, nitrogen, oxygen and hydrogen almost all the varied structures of the body are built up; how out of these elements, reconstructive plasm is fabricated; how out of the same elements an innocent product upon the one hand, and a violently noxious one upon the other, is formed, we shall know — at least, greatly more than we do now.

Transportation of the Molecule.

The molecule of infection being possessed of a *specific energy* as representative of its atomic constitution or arrangement, is operative through whatever means of trans-

portation it may find, until it is brought within the reach of agents, which decompose or resolve it into its elements. The energy pertaining to each variety of infectious molecule, varies in a degree which renders it more or less easy of destruction. The molecule of small-pox retains its composition with surprising tenacity, while that of vaccinia rapidly loses its specific character. The molecule of cholera, finding a congenial nidus, will retain its properties for a considerable time, when being suddenly eliminated, we are deluded into the belief of the possibility of a sporadic origin of that disease. And so with scarlatina and other diseases, which seem never to leave some of our large cities.

It will be objected, doubtless, that theories resting upon others not yet demonstrated beyond dispute, must be purely speculative and insusceptible of any convincing proof. But it should be remembered, that many of the bases upon which the foregoing reasoning proceeds, are as absolutely fixed as the laws of the physical world, and the precise methods of chemical combination. The molecule is an established entity; and though lying far beyond the reach of human vision, it has been measured and weighed and found to possess dimension and gravity. It appears, therefore, a rational course to attempt an explanation of the difficult problems relating to the human economy, upon the settled principles governing organic and inorganic existence.

The whole subject is replete with fertility of suggestion, and furnishes inviting channels for a new departure in pathological research. The author regrets that he cannot pursue it further, consistently with the scope of the present volume.

CHAPTER VII.

Generalizations From the Facts.

The foregoing pages have shown certain facts relative to a complete or partial immunity, of particular portions of the south Pacific coast, from the general ravages of the acute infectious diseases. In connection with this fact, the peculiar physical conditions of the region have been dwelt upon; and subsequently a line of reasoning was developed going to show, that the reproducing agents of the whole class are molecules, representing the constitution impressed upon them by the vital-energy involved in each particular morbid movement.

The reader will draw his own inferences from the facts herein presented. Many illustrations in support of the particular views relating to the ætiology of the diseases, have been advanced, which must be taken for what they are worth; but to the writer it appears certain, that just as a thunder-storm in our northern regions will temporarily mitigate an epidemic visitation; that just as the same influence is sufficiently powerful to split up the molecule of sugar in an animal fluid, so the *peculiar electric energy* of the region under consideration, operates to *decompose* the infectious molecule of exotic diseases, and prevent their development.

If there be any to doubt the potent agency of the electric energy in the production of molecular change, let them consider for a moment the illustration heretofore offered in these pages, concerning the influence of electricity upon

fresh milk. Entirely sweet and recent milk suffers almost immediate decomposition of the sugar molecule, during a thunder-storm, with a subsequent coagulation of casein from the development of lactic acid. This result transpires while the milk is entirely protected from the air external to the dwelling; and also, when it is placed within closets, ice-boxes or cellars.

This is a very remarkable—and so far as the author's knowledge extends—an unnoticed fact, as related to the subjects now engaging our attention. It furnishes a convincing illustration of many of the principles insisted upon in this work; and particularly exemplifies the truth of the statement above made, that conditions of peculiar energy are competent to decompose an exotic molecule of infection.

As a summing up of all the preceding statement of facts and arguments, the author believes that we are justified in the following generalizations, as to the acute infectious diseases.

First. That each one of the class possesses an original habitat or indigenous locality.

Second. Then when one of the type is developed in a locality foreign to the disease, it occurs from a transportation, not of the original cause, but of the representative results of the disease.

Third. That the original producing agent may be of animal or vegetable character, coming immediately from animalcular or micro-phytic forms, or directly or indirectly from the lower animal creation; and it would appear not impossible, that a contagium of specific character might be wholly inorganic in constitution.

Fourth. That the contagium of a type-disease in man, does not consist of vegetable germs, but is a product of a preceding type-action, and is representative of that action

in its atomic construction; and possesses the property, under vital and physical laws, of inducing the typical action in a healthy system.

Fifth. That atmospheric aridity to the extent existing upon the south Pacific coast does not destroy phyto-germ life; and hence, cannot be the cause of the exemption of that coast from the acute infectious diseases; nor can it be said to decompose either animal or vegetable germs; but upon the contrary, is rather preservative of them.

Sixth. That violent electric energy, as an agent powerfully operative in inducing energic transmutation, directly decomposes the infectious molecule by chemical rearrangement or breaking up of its atoms.

PART V.

THERAPEUTICS OF THE INFECTIOUS DISEASES.

CHAPTER I.

General Measures.

It forms no part of the purpose of this small volume, to reiterate the remedial measures now considered appropriate in the treatment of the various diseases classed under the head of acute infectious; such measures are fully dwelt upon in the text-books of medicine. But in following out the line of reasoning developed in the preceding pages, the attempt may not inappropriately be made to connect cause, effect and remedy by such lines of inference as positive deduction, and the unstrained logic of the facts will permit; and thus, while not advancing directly toward *specific* medication, we may be aided in the attempt to unravel the mysteries of ætiology, so important as an antecedent to successful therapeutics.

The modern physician has learned to treat these diseases largely upon general principles of hygiene, including cleanliness with disinfection, thorough ventilation, and isolation. Beyond general principles, however, he has no list of specific remedies. It is possible, and perhaps probable, that time will develop remedies as specifically potent, at least, against the causative agencies of small-pox, scarlatina, cholera, etc., as is quinine against that which lies behind the malarial

affections. At present, we have a few substantial lines upon which to base a general defense, in behalf of the common welfare.

Organic Germs.

Nature teems with the germs of organic life, which only await the requisite physical conditions, for development into their representative types. Unfortunately, we have no accurate knowledge connecting these multitudinous forms with the precise conditions under which they live; nor can we positively declare that the low forms of micro-vegetable life, which are supposed capable of producing disease in the human being, are competent to exist in the typically pure atmosphere designed for the support of the higher forms of the animal creation. There are some significant facts, however, bearing upon the question; but without going into these at all, a few simple things may be advantageously recalled in this connection.

Oxygen in Health.

A certain quantity of pure oxygen is an absolute essential to human life. The extent to which our air may be charged with other gases, either acting as simple diluents, or inherently noxious in character, and still be capable of supporting life, is but a question of quantity with individual constitutions. From the florid health tinge of a well-ventilated residence, to the cadaverous hue of the dweller in the slums, there is, *cæteris paribus*, a sliding scale pretty closely related, without doubt, to an exact percentage of oxygen gas. Further than this, it is equally certain, that a recession from the normal air-constitution through which a given volume of the atmosphere shows a diminished percentage of oxygen, is productive of myriad forms of microscopic life, which before were insusceptible

of development. Hence, upon simple experience, we have learned in practice to "purify" and "disinfect" the various sources of noxious emanations; these terms simply implying the destruction of those organic forms, and a prevention of their further development, which are in any sense, pernicious to health; as also the metamorphosis of noxious gases into more innocent compounds.

Nature's Disinfectants.

These are, chiefly, three in number, each dependent for its salutary properties upon the yielding up, or evolution of oxygen. These bodies are, the allotropic substance called *ozone;* the peroxide of hydrogen, or *antozone* as it has been called, and the nitrous acid, all three of which have a greater or less percentage in the normal atmosphere, according to the greater or less activity of those causes which produce them. The air of our planet, at ordinary levels, is seldom of an even approximately pure character; and in connection with the haunts of men, and particularly where aggregated in large communities, it is loaded with organic and inorganic impurities to so great an extent, that were it not for a wise ordering of nature, the present air-breathing animal might abandon the world to the amphibia of primitive ages.

Nature's disinfecting processes, first, through wind-movements, which scatter and dilute impurities, and second, through positive chemical destruction, are carried on upon an immense scale. The potent form of energy, heat, with its twin-brother electricity, constitute chemical reagents, which keep the cosmic laboratory in constant activity — now in analysis; now in synthesis; now in metathesis. In all these stupendous operations, resulting in the benefit of man, we cannot fail to recognize the agency of a single

principle, about which so much has already been said in these pages — this being the body oxygen. Directly or indirectly, it stands our best friend; in its presence we live — in its recession we droop — in its absence we perish.

The Stamping-out Process.

Hence, as before remarked, partly upon a scientific and partly upon an empirical basis, the physician combats the infectious diseases as a class, upon the general principles so hastily touched upon. These are cleanliness, isolation, ventilation and disinfection, which constitute the essential features of the "stamping-out" process; and which have rendered this class of maladies so greatly less destructive in our time than in the periods gone by. We hear no more of the terrible ravages formerly committed by them, except when breaking out in armies, or in localities insusceptible of the discipline necessitated by those preventive measures which we rear against the enemy as barriers, when attacking our large communities. Even in the case of a disease not falling under particular consideration in these pages, whose original virus is conveyed by personal contact; a disease which has figured most infamously in the history of the world, passing in varied forms from one generation to another, and leaving mental and physical degeneration in its trail, we witness a steady recession before the lights of modern advancement. To so great an extent has the general prevalence of this disease decreased, and especially among the more intelligent, who know the power of scrupulous cleanliness and immediate disinfection, that he would not be considered a rash prophet, who might predict the ultimate extinction among all intelligent peoples, of the disease-class produced by a venereal virus.

Improved Health Rates.

It would further seem, that the premature-mortality rate of the enlightened nations has appreciably decreased during the past quarter of a century; while it must be admitted by all who are in position to take an enlarged survey of the field, that with our modern methods of investigation and constantly accumulating knowledge, results are promised, both in the prevention of disease-producing states and conditions, as well as in the treatment of actually established morbid action, more positive and more nearly approaching certainty, than the individual looking from the standpoint of twenty-five years ago would have deemed within the range of possibility. Whether or not the world's population in detail, is to receive the practical benefits of these results must be determined by the future. With the ability to construct dwellings upon model health principles, comes not only the ability but the inclination to live luxuriously; and it still seems manifest that the hard conditions involved in the injunction, "live on sixpence a day and earn it," contribute less to the prosperity of the doctor than the dissipations, extravagances and criminalities of indolence and wealth. The individual who divided the people of the world into two great classes — those with more appetite than dinner, and those with more dinner than appetite — was more of a physician than he knew; for in his saw he represented the extreme points of two distinct classes of disease-departure. He would have been still wiser, had he been able to follow the separated paths to their union in the common road, with a common ending.

CHAPTER II.

Special Measures.

Notwithstanding the great obscurity surrounding the precise causes of the infectious diseases, some positive and unequivocal advances have been made within the last decade in their special treatment; which, however, may be said to represent in the local application, those general measures of prevention and management briefly described in the last chapter. The author does not mean to state that any single remedy has been found, which may be said to be specific, even in the sense in which quinine is supposed to be specific; but that a few agents have slowly accumulated which, as has before been stated in these pages, are probably represented in their ultimate effects by a single principle; which latter possesses a physical basis for its distinctive operation.

It is unnecessary here to enumerate the particular remedies comprising the class above alluded to, or to restate the principles so fully discussed in the preceding parts of this volume. The author believes that from the present starting point, a new therapeutic departure must gradually take place. But we have some things to unlearn before we begin the work of learning others; and perhaps the first step necessary to be taken, relates to discarding the old as well as the present idea, that the infectious diseases as a class, are immediately caused by animal and vegetable organisms, which, gaining access to the system, multiply themselves, and in some mysterious manner evoke a specific-disease form. Then we should be in a position to realize that all

of the low forms of existences arise from germs whose development is possible only, under certain peculiarities governing the general constitution of life and matter; that these peculiarities as a rule, are connected with the processes involved in organic decomposition, and that when the latter occurs the germ development takes place almost *par conséquence.* Hence, the constant association of fungi, bacteria, *et id omne genus,* with the morbid processes of the human body involving active molecular decomposition.

Let it here be understood, however, that the author does not deny, that low organisms produced from sources external to the body, may set up diseased action in the system; this he has admitted as the possible primitive causes of the infectious diseases; though he is of the opinion, that like the occult forms productive of the malarial affections, they are so minute in character as to lie far beyond the reach of any means we yet possess, to bring them within the field of vision. The statement made, principally goes against the *reproducing* agency, itself, which the author believes, must occur under the conditions previously set forth.

Energy Determines Forms of Life.

If it were true, that the original energy of nature, directly and indirectly determines the molecular constitution of all living forms; that man, as a simple, ideal illustration, constituting the highest form, stands for the plus or positive sign; and the very lowest of all organisms as the minus or negative sign, then as must be evident, the existence of either and all intermediate grades, is but a question of state, or *condition.* The whole animated world teems with instructive analogies upon this very point. But our conclusions are running in the inverse order; let us attempt to arrive at some practical application.

Impress of the Contagium.

An analysis of the symptoms of the acute infectious diseases seems to show very clearly, that, while the producing cause, or contagium obtains access to the system through the circulation, and at once begins its work of molecular disturbance, the general outbreak of the disease does not occur until the *nervous system* itself, becomes sufficiently impressed by the morbific influence; when the morbid movement constituting the particular disease begins within, and radiates from, the nervous system.

As confirmation of this, let us consider the source and import of *vomiting*, so often preceding the development of the diseases, as a class, as well as of others, whose implication of the nervous-axis is unquestioned; of *convulsions;* of *headache;* of general *pain* and *aching* in the back and limbs; of *chills*, so often witnessed as a purely nervous phenomenon disconnected with fever; of the *thermal* manifestations attending the febrile movement; and lastly, of that remarkable phenomenon, *periodicity.*

This latter feature, represented most remarkably by the malarious influence, shows itself in the periodical wear of the nervous-energy requiring recuperation by sleep; by various normal functions of *cyclical* character; in various diseases, and in the affections of the nervous-system called functional, represented by neuralgic disturbances, and which are always of more or less pronounced periodic character. Nor is any one likely to overlook, in the consideration of such a subject, the case of one M. Brachet, who, taking a bath at midnight in the Seine, had a regularly-recurrent fever, the periodicity of which was as marked as that attending the malarial impress. And these data suggest an inverse reasoning upon a line like the following:

Whatever the influence which may cause malarial fevers, and as an extension of the subject of *every* variety of periodic manifestation, it affects essentially, and more or less directly, the *nervous-system ;* which being the case, a basis, at least, exists for the belief, that those remedies which counteract periodicity are operative upon the nervous-system; and hence, quinine, *in the sense of neutralizing the poison of malaria* itself, *is no specific at all.* The effect of quinine in killing bacterial life out of the body, may be cited against such a supposition ; but to this it need only be replied, that many agents, as chromic, boracic, benzoic, salicylic and carbolic acids have the same property to even a greater degree, and yet possess no antiperiodic virtues.

The inference receives support, however, from the established therapeutic resources applicable to the whole class. A timely dose of opium, for example, will often arrest a paroxysm of ague ; as will also a stimulant, as of brandy or pepper, etc.; and though more rarely, violent emotion, as of anger and fear, is often attended with the same result. More decisive still, in illustration, are those remedies which, while acting more slowly but no less certainly, are known to exert their effects, rather upon the nervous-system than upon the immediately-producing agent; such are arsenic, strychnine, nitric acid, and other remedies of the kind.

Eliminative Remedies.

As a closely-related subject there may be mentioned in this connection, the remedies for another of the infectious class, though embraced under the *chronic* list— the syphilitic disease. These remedies are directed to the "elimination of the poison" from the system, as though it were an intruder susceptible of bodily ejection. Nothing, as it seems to the author, can be more manifest, than that

the disease, like many others, is one of *condition*, functional or structural; and that our remedies can only be operative as against the morbid movement constituting the disease itself. As well might we go back to the old idea, which regarded heat as an entity capable of entering a body; or to the first popular conception of the telegraph which imagined letters actually sent over the wires, as to regard disease in any form as essentially composed of morbid matters in the blood. Morbific matters there may have been primarily; but their impression has been made upon such parts as are susceptible to the impress; and the diseased movement consists of the *consequences* of the morbific imprint upon the previously healthy structures and functions. With the proper limitation, we can all agree upon the general proposition embraced in the words, *sublata causa tollitur effectus;* but as a preliminary to removal, it seems quite necessary to first recognize the real nature of the cause.

The Antiseptics.

Within the past decade, more particularly, a class of remedies have been gradually accumulating, one well-settled property of which, among others, is the power to destroy, or prevent the development of "germ life"; and hand in hand with the appearance of the remedies mentioned, has been the evolution of a new principle in therapeutics, which has assumed the name of the "antiseptic treatment," Largely applied by Lister in external application to surgical cases, its use has likewise extended to the *internal* treatment of many diseases, and particularly to those of the infectious class. Much was hoped for, from the antiseptic principle in the latter direction, but it can scarcely be doubted, that the hope has been blasted by the experience.

This result might have been anticipated by a more careful consideration of known facts. There can be no precise parallel between the action of antiseptics upon the *surface* of the body, and *within* the stomach, and circulatory round. If a person suffer a wound upon the surfaces accessible to the atmosphere, molecular death of a portion of the injured structure being a necessary consequence, the development of aërial germs in connection therewith, extends the retrograde results and prolongs the period of recovery. The action of antiseptics in these cases, is simply to prevent parasitic involvement; and thus the normal processes are permitted to repair the injury without complication. The use of these remedies may be properly extended, as is done, to all exposed surfaces, as the mucous membrane of the whole respiratory tract; and even to the stomach, in the arrest of fermentation, etc. Under this view, however, the action of antiseptics is not *directly* curative.

But if the infectious diseases, as a class, really have, as claimed, their causation in bacterial development within the circulation, we could not reasonably expect any specific influence upon them, through antiseptics administered *via stomachi*. If a medicine be directly absorbed from the stomach into the circulation, it must encounter, primarily, the action of the digestive fluids, a greater or less flow of which, is provoked upon the introduction into the organ of even very small quantities of solid or liquid substances; and secondarily, be subjected to the immediate influence of the blood itself, which, as containing some free principles, may at once impress a different chemical character upon it. If the medicine go the whole digestive round, as some medicines unquestionably do, it must mingle with the digestive juices, and still pass the liver and lungs as before, prior to entering the systemic circulation. In either case, unless

the article have a very fixed composition, it seems not at all probable, that its original chemical character is preserved up to the point of infusion into the general circulation.

Elementary substances, and the active principles of medicines, which latter are very fixed in composition, enter the general blood-current, and may afterward be excreted by the natural channels; but our imperfect knowledge does not enable us to decide the question, as to whether the vital chemistry does or does not ultimately work out a compound differing from the article as first introduced.

The sulphate of morphia when taken into the stomach, in sufficient quantity, produces hypnotic effects, as it also does, when injected into the subcutaneous cellular tissue. In the first case, however, a greatly larger quantity is required to produce the same effect or impression, than in the second case. This result is usually attributed to the fact, that the medicine as administered *per injectio* (*via compendiaria*), is directly absorbed, and thereby manifests its effect without the loss or waste which takes place *per viæ primæ*. This may be the proper explanation; but there is a point involved in the question, which the author cannot believe settled.

As an illustration of the principle above maintained, it may be mentioned, that Dr. Halford, of India, has found that carbolic acid will neutralize the virus of that deadly reptile, the *cobra di capello outside* of the human system; but when administered to a patient after the poison has been introduced into his system, the agent is powerless for good.

The whole matter, however, may be disposed of by the statement that, so far as relates to the internal use of the antiseptics in the infectious diseases, the question seems

quite settled, through their demonstrated inability, in any form or combination, to prevent or cure these maladies.

The Disinfectants.

Is the conclusion of the whole matter, then, so lame and impotent, as to leave us no resources of a positive character with which to combat the acute diseases of this class? Not precisely; for outside of the many special remedies advised in the text-books, we may follow a line of procedure already marked out by others, though running abreast with the philosophy of these pages, and certainly capable of much greater extension, as different views of ætiology shall come into general recognition.

In the treatment of individual cases, the general measures of prevention, summed up in the processes of disinfection, cleanliness, ventilation and isolation, are locally applied, so to speak, to the patient and his immediate surroundings. The observation of the author has taught him, however, that these measures in practice are not often sufficiently radical and persistent in character. A patient with scarlatina, for instance, should be isolated as rigidly as possible, while disinfection should extend to the surface of the body; to the bedclothes and surroundings; to the excreta from the bladder, as well as from the bowels; to the attendant's hands and clothes, etc.

And in connection with the subject of domiciliary disinfection, attention may properly be called to the pernicious influence of the modern water-closet, as now constructed in all residences of any pretension. The system of trappage is exceedingly defective, while no provision whatever is ordinarily made for the escape of gases, which of necessity find vent into the house itself. If we add to this evil, the carelessness of at least one half the people in

not permitting the water to run sufficiently long to flush the waste-pipe with effectiveness, we can easily realize the great source of insalubrity which exists, like a skeleton, in every closet.

In houses where the bath-room and closet are together, we have a most valuable means of disinfection which does not seem to be utilized. This may consist in having an adjustable hose to reach from the hot-water faucet of the bath to the basin, whereby a stream of very *hot water* evolving steam, may be turned into the closet and allowed to run for an hour or more, every day. All modern houses should be so constructed as to allow of the complete flushing of the closet with hot water; than which there is no more effective and available disinfectant. This provision, with a ventilating pipe for the escape of gases above the house-top, would greatly diminish the causes of disease, both of general and specific character.

The air of a sick chamber should not only be diluted by the admission of fresh air, which in epidemic seasons likewise contains the contagium, but also *purified by disinfectants*, artificially generated. For purposes of personal and local disinfection, the effective agents and their methods of use, are too well known to require mention in these pages.

For atmospheric purification, no agent exceeds in power and effectiveness, nature's disinfectants, the artificial production of any of which, is quite within our ability. If the unmistakable drift of the author's logic have any force, the mere existence of an epidemic implies an abnormal state of the atmosphere, involving a *minus* condition of the general energy — an expression which will be permitted upon the score of representing an idea, if not a critically accurate fact. Hence, the simple admission of fresh air

to a sick chamber, while it may and does dilute the aërial virus, cannot dissipate or entirely destroy it within the chamber. But a disinfectant proper *will* destroy it; and the only obstacle to complete success, consists in our inability to apply the principle upon a scale of sufficient extent. If we cannot vanquish the enemy *en masse*, however, we can cope with him in detail. Every hospital should be provided with a machine for the generation of *ozone*, and particularly every hospital where the infectious diseases are received for treatment. Private houses and chambers should be subjected to the influence of aërial disinfection by a machine, or by chemical mixtures through which ozone is evolved. The great want of the profession in this direction, is a small and inexpensive ozone machine for family use; which, it is to be hoped, will ere long be supplied. In the absence of a machine, a very convenient mixture for the generation of ozone is that recommended by Böttger, which consists in mixing very *gradually*, and in an *open* vessel, three parts of strong sulphuric acid with two parts of potassium permanganate. This compound will evolve ozone for a considerable time, and can be used in various places about the house — the only precaution necessary in its use being, to keep it out of the reach of children, and away from flame, which may ignite it.

In all this there is nothing new, however; but as before remarked, we do not get the benefits from such measures which they are capable of yielding, because of the lack of system in their application, and of efficiency in carrying them out.

Supporting Remedies and Measures.

As to the more special measures, one general principle cannot be too constantly borne in mind and acted upon, viz: that every morbid movement involving functional

activity, necessarily implies severe drain and rapid transmutation of *energy*, and as a consequence, a more or less rapid and exhausting molecular decomposition. Hence, the necessity of supplying fuel which may sustain the system under the destructive waste of these processes; or at least until their force is spent, and the reconstructive effort be fairly established. With this view, the resources of nutritive upbuilding should be taxed to the uttermost consistently with special conditions; and particularly is this injunction applicable to that class of the infectious diseases, whose symptoms and results do not vanish with the original disease; those, in other words, which leave a train of morbific sequelæ behind them.

The tendency of many of the diseases of this class to depart from a purely functional character, either by special drift toward parenchymatous involvement, or as legitimate consequences of the antecedent morbid movement, and to work *structural* changes in particular organs, or in the nervous-axis itself, constitutes their chief danger, in those subjects not overwhelmed at once, by the intensity of the primary onslaught.

The nervous-axis is of organic construction, and while furnishing the principle of life which animates all other portions of the body, is itself, subject to the changes which disease may bring about in the organic molecule. Hence, it is not in any sense, exempt from the congestions, inflammations, etc., with their subsequent products and alterations of structure, which may attack any organ, or portion of the body. When such structural alterations, or tissue-destructions, occur in the nervous-axis, whether from the infectious or any other diseases, it is needless to say, that the result is as unfortunate as irreparable, and limited in consequences only, by the extent and importance of the

spoiled part. A man may lose an eye or an ear; a lung or a kidney; an arm or a leg; and subsequently enjoy perfect health, and perhaps an unabridged term of life. But when the structural integrity of that wondrous piece of the human mechanism, which is at once the mainspring and general cogwheel, by and upon which all the others turn, becomes impaired, the extent of disarrangement to the whole machine, can only be measured by the extent and importance of the missing parts. A single note may be dropped from the many voices of life's chorus; or the discord may be so intolerable as to convert the soft melody into a despairing wail. Compensation of function through symmetry of anatomical parts may take place, perhaps, as is claimed by some physiologists; but it can only be within the most restricted limits. Hence, while we may reasonably hope to overcome functional aberration by the resources of art, we can no more expect to replace the spoiled mechanism of an organ which not only feeds and upbuilds all other organs, but also, supplies the conditions of its own perpetuation, than we can assume an ability to construct that marvelous organ *de novo*.

In the management of the infectious diseases, then, there is a wide field for effort in the direction of limiting the morbid movement, to the mere involvement of function; and of preserving structure itself intact, throughout the uncertain struggle with the disease. This effort will consist, at one time, in repressing activity of movement; and at another, in obviating the tendency to undue depression. Particular remedies for both indications, form important desiderata in the therapeutics of these diseases.

Nervous Calmatives and Belladonna.

In the matter of strict medication, too, there are a num-

ber of collateral indications to be fulfilled; for the accomplishment of which, many remedies are generally relied upon by the profession. Of these, the class which allay nervous excitement and irritability, and which are thereby conservative of the vital energy, should hold a prominent place.

The claim has been largely made, that in belladonna we have, not alone a prophylactic against scarlatina, but a remedy capable of curing the established disease. Unfortunately for the interests of humanity, experience has rendered a decision against the validity of this claim, but the undoubtedly good effects of the remedy, in controlling certain symptoms through its peculiar impress *upon the nervous centres*, leads to the hope, that an agent of the class to which it belongs may yet be found, whose virtues may be more pronounced in both character and extent.

Dr. Bartholow, in his classical work upon Materia Medica and Therapeutics, urges the value of aconite in certain stages of the eruptive fevers, especially in scarlatina, and the writer can fully indorse his views. Dr. B. places this article under the head of Motor-Depressants, to which class it certainly belongs. Under our present imperfect knowledge, both of the physiology of innervation and the *modus operandi* of medicines, we can form no rational opinions as to the real nature of the primary impress of those agents, which affect the nervous system in a manner so pronounced. The author believes, however, that they are capable of more extended usefulness than has generally been accorded to them; not as specifics in the proper sense, but as counter-actives to the morbid movement involved in the particular disease under treatment.

The Iron Sheet-Anchor.

At some particular stage of all the diseases, which, by

failure to run a mild and rapid course, do not leave the natural powers in that unimpaired condition insuring a speedy rebound to typical health, it becomes necessary to administer a remedy, which, of all others, is worthy of being called a sheet-anchor. This remedy is *iron*. The purpose for which it is commonly given is "to make red blood-globules," and that it does so is true enough, though the precise reason *why* the making of red blood-globules, should conduce to the especial benefit of the patient, is not generally recognized, perhaps. We have an indefinite expression which classes iron as a *tonic*, but *why* is it tonic? The author will, presently, attempt an answer to the question.

Possibilities as to the Future.

Is the idea running through these pages, from which it appears that the mere animal life is but the representative of a principle, which we know to underlie the mighty secrets of cosmic order and existence, founded upon reality, or is it a theoretical abstraction? To him, who stepping out of the furrow of exclusive thought, grasps, so far as the finite mind may grasp, the great facts of the Creative plan, there can be but one answer.

What the future may bring forth we know not. We have but one potential fact upon which to base an estimate of its possibilities — a retrospect of the past. The abstract conception of general force antedates the philosophy of our day; but almost to our own century belongs the bold act of calling the invisible slave of the lamp to our service, and harnessing him to the car of modern progress. We call him from the immeasurable leagues of space; we clothe him in the garb of *motion* to serve our purposes; at a pass of the wand, we metamorphose him into *heat*, when he works at the factory, the loom and the forge; at another

pass, he illuminates the darkness and supplements the sun; at another, he becomes the swift-winged Mercury, and carries his messages with the rapidity of thought; and at still another, we lay him upon a shelf, and bid him there remain until we further need him.

In full view of these facts, then, is it a wild dream, that to him who is vested with such magic powers, there must come, soon or late, a knowledge of the general mechanism, at least, of his own physical existence; and with that knowledge, the craft necessary to keep its wheels in motion and repair, until the climax arrives fixed upon by the Great Artificer, as the signal for their final stoppage?

Oxygen as a Remedy.

If oxygen as a principle of the higher organic world, have the important agency in the phenomena of animal life herein attributed to it, surely it should be susceptible of some therapeutic application, even if indirect and limited to certain maladies involving the central energic-axis of the system.

One of the modifications of general energy — the *electric* — has, within a few years, come into extended therapeutic use; and properly applied is, without question, capable of most potent service in the treatment of various ills; though as yet the subject of electro-therapeutics is as much in its infancy, as was the first rude telegraph constructed by Morse with double wires; and doubtless the electro-therapeutist of to-day would be as much astonished at what the next half century may develop in his field, as would the inventor of the telegraph to know, that not only are messages sent upon a single wire, but that as many as *four* are transmitted at one and the same time.

As a means, in addition to those already mentioned, of

recognized usefulness in the direction, not only of upholding the energic power, but also of interposing a hand in the molecular changes going on, is there any possible channel through which we may attempt an application of the principles herein dwelt upon at such length? If the body oxygen have the extensive relations which it appears to possess, is it practicable to utilize it, until some broader and perhaps deeper principle may be evolved through advancing science? The author believes that these questions are destined to occupy, extensively, the future attention of the medical philosopher and the therapeutist. What the verdict will be, the future alone can reveal.

But there are, at least, two articles which experience — that great teacher — has demonstrated to be of signal utility in nearly the whole class of the acute infectious diseases; either from the first, or at a later stage of the individual maladies. These articles are IRON and the CHLORATE OF POTASSIUM — the former frequently in form of the muriated tincture, and more lately as prepared by dialysis; and the latter, in combination with it, or in separate dilution.

What are the peculiar virtues of these remedies? Curiously enough, they have direct relationship to the very question we are considering — the body oxygen. It is not necessary to go into details of method; but the broad fact is well established, that the effect, *par excellence*, of iron, is to *increase the red-blood globules* in number, which increase *of oxygen carriers*, necessarily implies an *increased amount* of *oxygen carried.*

Water as a Source of Oxygen.

It has been elsewhere stated, that water contributes to the oxygen supply of the system. By this statement the author does not mean to assert that decomposition of

that fluid takes place within the system. It is a familiar fact, however, that good, potable water contains a large percentage of free oxygen in solution; or at least in such state as renders easy its appropriation by the system. Few things are so flat and insipid to the taste, as water deprived of its gaseous element by boiling.

In the acute stages of fever, involving rapid motion and quick transmutation, the craving for water is one of the most prominent features. This craving, of course, is, in part, a natural demand of the system for fluid to supply the drain which begins immediately upon the accession of the febrile movement. Whatever theory we adopt, however, as to the production of animal heat, oxygen is the radical factor of the process. We may believe with Virchow, that the production of heat results from the increased amount of oxygen carried to the whole, or any part of the system, whereby "nutrition" is increased; or, in other words, "combustion" is promoted. Or, we may adopt the views maintained in these pages, that a portion of the result, at least, is due to the immediate impress of oxygen upon the nervous centres, whereby *energy is evoked*, resulting in motion, which latter is ultimately transmuted into heat; and if it be abnormally rapid motion, into an abnormal heat.

While he does not desire to go into a disquisition upon the intimate nature of fever at this time, yet it becomes necessary that the author remark in this connection, lest an apparent contradiction of opinion be here detected, that he does not regard the febrile movement itself, as constituting essential disease, but rather a *symptom* of disease.

But to return. Oxygen, under any view we may take of heat-production, is an absolute requisite. During the febrile movement, increased respiratory action affords an increased amount of oxygen to the system, to which increase

water may contribute. This view seems strengthened by what the author believes to be a general fact, viz: that water which has been entirely deprived of its free gaseous constituents, *does not satisfy the thirst of fever*, as does ordinary drinking water.

When we reflect upon the imperious demand of the system for water in all rapid movements, normal as well as abnormal, which involve the excessive production of heat, and this, usually, before any great loss of fluid by transpiration occurs, it seems that we cannot regard water, exclusively, as a mere diluent in the system; but that we must also recognize in it a reserve store of a principle, which underlies the facts of heat and motion, whatever theory of the modus of production we may entertain.

Why Iron is Tonic.

Iron is an agent which is *tonic*, not because of any plasmic material it directly supplies, but because *it multiplies the agents which carry the vivifying oxygen to the nervous-axis;* and in thus upbuilding the vital energy, upbuilds the whole series of nutritive and other functions over which that energy presides.

The chlorate of potassium is an oxygen-yielding body — so loosely holding its combination, that it gives away its oxygen upon the least solicitation. The chemist finds in this article the readiest means of obtaining the gas; and in the animal system decomposition must readily occur — the liberation of oxygen being the prominent result.

This, however, is denied by some, who base their opinion upon the declaration of Wöhler, that he had obtained the salt in the urine of a patient, to whom it had been given, in an entirely unchanged state. It is to be regretted, that so many of the accepted facts of medicine are founded upon

observations equally incomplete as this of Wöhler. Even if the whole amount of the salt taken into the stomach had been fully accounted for, in a subsequently unaltered condition, the observation as a prime fact relating to the article, would be valueless without the corroboratory evidence of associated conditions. O'Shaughnessy and Stevens found that it imparts a bright arterial color to venous blood, though the former claims that it passes undecomposed into the urine. A *portion* of it may do so, as observed by Wöhler; but it can be only that portion in excess of the *oxygen-capacity* of the "carriers." The chemical facts pertaining to the composition of the salt, are too well established to be overthrown by observations of such imperfect character.

Experience, the safest of teachers, has demonstrated the efficiency of both these agents in many of the diseases we are now considering; and it may justly be claimed, that with quinine, they assume more nearly the character of *specifics*, than any of the multitudinous remedies still in therapeutic vogue. It must be confessed, however, that we have stumbled upon their use, rather than reached it by any precedent reasoning. There are some other remedies, too, standing in much the same position, though their acceptance has not become so general; and hence their efficacy is not so well attested. These are remedies which carry oxygen in the allotropic form, directly to the system.

The Ozoniferous Ethers.

The bodies so termed, absorb oxygen by direct exposure to the light and air, and yield it up readily to the system. They were first brought to the attention of the profession by Dr. Richardson, of London, more particularly as disinfectants. They are very useful for purposes of personal

disinfection; and hands, body and clothes may be sprinkled or sprayed with them. Their efficacy as internal remedies, should have a more extended trial.

The inflammability of the ethers should not be forgotten, and care must be exercised to prevent ignition.

The Terpines.

This is another class of agents, which the author believes capable of great usefulness. By exposure to the air, they absorb oxygen freely, which during the subsequent chemical changes, whereby resin is produced, is converted into ozone; and this latter is readily given up to the system upon internal administration. They are emphatically "ozone-carriers."

The terpines are volatile oils, and are obtained from plants of the coniferous and aurantiaceous orders. In the class are embraced the ordinary oil of turpentine, representing the first order, and the following, representing the second, and being isomeric with the oil of turpentine: lemon oil; oil of the rind of sweet orange; of the lime; of the sweet lemon; citron; cinnamon; bergamot, etc. The neutral oil of gaultheria and light oil of cloves, are also isomeric with the oil of turpentine, and both contain salicylic acid.

The oil of turpentine is the most available of the list for medicinal use, and has been administered to some extent; particularly in those diseases of the infectious class, whose expression lies upon the mucous membranes of the lungs and intestines. As an oxygen-carrier, the author has to suggest its preparation by direct treatment with, either ozone or oxygen gas, instead of by simple exposure to the air.

Ozonized Charcoal.

Reasoning from a similar basis, it seems possible to find

means of conveying the oxygen principle to the system, so as to comply with those, at present, unknown conditions of utilization which, it is to be hoped, the lapse of time and course of experiment may teach us. Charcoal, through its well-known power to absorb gases, might be made available as an oxygen-carrier, though, as yet, no trial for this purpose has been made. The author would suggest that vegetable charcoal, as of willow or box-wood, directly treated with ozone gas, be given a trial in proper cases. It would be first necessary to expose the charcoal to a moderate heat, in order to expel all moisture or other gases, before treating it with the ozone. In this form, charcoal should have a beneficial influence also, in the intestinal diseases of children and adults.

Oxygenized Water.

Dr. Richardson, of London, has also advised the use of a solution of the peroxide of hydrogen, or oxygenized water. It is a deutoxide of hydrogen, with an additional equivalent of free oxygen. His recommendations do not particularly extend its use to the infectious class of diseases, but doubtless, it has a chief value in that direction. It should receive extended trial.

The mode of preparation is simple; one method for which may be found in the last (14th) edition of the United States Dispensatory.

Oxygen by Inhalation.

Oxygen may be introduced into the lungs by cautious inhalation, with much advantage, in nearly the whole class of the acute infectious diseases. In both *scarlatina* and *small-pox*, the author has seen the disease apparently aborted, by the direct inhalation of the gas. In *diphtheria*, the gas

may be projected upon the false membrane, in the form of a jet or spray, from a bag fitted with an appropriate nozzle. The effect is sometimes to melt away the former, leaving a healthy surface underneath; oxygen and iron being at the same time supplied to the general system. The author has also seen two cases of *membranous croup*, of an apparently desperate character, get well under the repeated inhalation of the gas.

In a case of *tetanus*, in which the gas was administered by inhalation, the result was most striking; the spasm ceased in a short time, and upon the return, a few hours later, again ceased upon the reinhalation of the gas; after which the patient made a good recovery, in connection with other remedies of a general character.

The writer, also, had an opportunity, upon one occasion, to administer the gas in a case of *post-partum convulsions*, with a successful result.

In all cases of septicæmic poisoning, the remedy should, and doubtless will, by experience, be found to be one of the most valuable agents in the whole list at our command.

Care must be exercised in its administration, and its use suspended upon the accession of vertigo, or other symptoms manifestly caused by the agent. Care should also be taken to admit a due quantity of atmospheric air to the lungs, while it is being given.

The Principle Involved.

If it be understood that the whole recommendation of the author, runs in the direction of finding the readiest means of flooding the system with oxygen gas, in an empirical and indiscriminate manner, then, indeed, has a great part of his labor been in vain. This gas, like any other, is susceptible of being placed within the system in larger

quantities than is possible through mere medicaments. It could be *pumped* into the stomach, and bowels, too, if systemic access were the simple object in view.

We are not now dealing with it as an antiseptic and disinfectant remedy; for both of these purposes it may have a valuable internal use. But we are considering it in another aspect; and from all we know of the conditions through which the *vital energy* or *force* is evoked, we are bound to conclude, that as oxygen in a simple gaseous state is powerless of itself, to evoke the electric energy when placed in contact with the cells of a battery, so there is a *method* by which oxygen must reach the nervous-axis, in order that it may become the magic wand with which to call forth the Genius of Life. This method is linked to the *red blood-globules*, which, whether they act as mere carriers of oxygen; whether they alter it in some unknown manner, or whether they contribute some unknown element, are, nevertheless, the only channel through which it can be made available for the support of vital energy. Hence, there must be a precise balance between the two elements; and oxygen is as useless to the system without the globules, as are the globules without the oxygen.

Refraining from further details as to particular remedies, which formed no part of the author's original purpose, it may be asserted pretty safely, that as the sum of our present experience in the specific therapeutics of the acute infectious diseases, (with the single exception of the malarial affections) we have established but one general and essential principle, viz: to support and conserve the strength and energies of the patient, until the morbid movement declines by a sort of statute limitation. This we attempt rationally, by contributing to the nutritive functions; and, empirically, by the administration of remedies, which di-

rectly or indirectly result in the *normal* addition of oxygen to the general system. Iron to maintain or increase the number of oxygen-carriers; and the administration of articles which supply the thing to be carried, hedge in the narrow boundaries of "specific" effort.

PART VI.

THE QUESTION OF ENERGY AS RELATED TO GENERAL DISORDERS.

CHAPTER I.

Brief Retrospect of the Subject.

The preceding pages have been devoted to the consideration of a particular class of diseases, and the facts as well as arguments heretofore set forth, have had for a principal object, the elucidation of the questions more directly bearing upon the ætiology of those affections. In their consideration the author has brought to the stand, such evidence as might be furnished by the varied circumstances which have been so hastily, and perhaps too briefly, passed in review; and to the end that every possible light might be thrown into the almost impenetrable darkness enveloping the subject under study, the domains of the natural sciences have been invaded, and the testimony they are capable of yielding has been earnestly solicited. Whether or not the conclusions which have been arrived at, are logically deducible from the premises, is a question to be decided by the future. The author is fully impressed with the potency of one fact, however; that in the discussion of that incomprehensible power or agency which presides with the absoluteness of a dictator over the realm of life, he has touched a subject, not only intimate in its relations with the class of diseases herein especially treated, but also with a much larger proportion of the maladies of the human race than is generally realized.

Extension of the Subject.

By this assertion he does not mean to say, simply, that we have fallen upon an era of nerves, and that all the class of functional disorders of the nervous system, have been greatly multiplied and augmented in severity. This would be but a portion of the truth, at best. What he wishes to convey is the fact, that many diseases involving change of organic structure in various parts of the system, have had their origin in a primary lesion of the nervous centres, either functional or structural in character. Hence, it seems an error to regard so many of the diseases which afflict mankind, in the light of distinct entities; while, manifestly, they but represent morbid conditions consequent upon a precedent derangement in the primary sources, upon which all action depends. As well might we consider dropsy in the aspect of a disease-entity, as make the attempt to erect a particular grouping of morbid actions dependent upon remote causes, and followed by changes of structure and function in the organs secondarily affected, into a separate personality, characterized by a special name. A great poet has asked, "What is in a name?" To which it may be replied: Though a name may have no especial import in connection with an odor, be it agreeable or otherwise, yet as considered in relation to the ills of the human body, it is a thing not to be lightly regarded. Names, as designative of diseases, have been productive of untold mischief; as through their agency medical charlatanry has been enabled to assume its present well-known proportions. The abolition of names would be a sad blow to the business prospects of those, who so successfully overcome coughs, catarrhs, liver complaints, bilious eruptions, dyspepsias, female weaknesses, etc. etc.

CHAPTER II.

Essential Construction of the Animal System.

If the proposition, that man is only a "two-legged animal without feathers," cannot be maintained in our day, yet his anatomical elements must be considered as essentially comprised of the *brain and spinal cord.* As has heretofore been stated in these pages, the animal life resides within those structures, or, more properly speaking, within that structure; as the organ, while consisting of different divisions and parts, is, nevertheless, possessed of all the attributes of anatomical and physiological unity. All other parts of the body are accessory to its material preservation and well-being. The lungs and stomach furnish it fuel, the former supplying a principle closely related to the evolution of the vital energy, and the latter the crude elements for its structural maintenance and repair. The various secretory organs elaborate and prepare these crude elements destined to the office spoken of, retaining the needful and rejecting or eliminating the unnecessary and harmful. The heart and circulatory apparatus convey the prepared elements to their varied destinations. A bony framework protects the organ from external injury, as it does also those organs accessory to its own preservation. It is supplied with a locomotory apparatus, through which it moves about; defends and feeds itself. It has a special apparatus for the perception of other objects; a special apparatus which takes cognizance of sounds; another special arrangement for communication by language; all of these con-

tributing, not only to the well-being and protection of this precious organism, but to the enjoyment of the principle it represents — the principle of Life. It has a special apparatus for the propagation of its species. It has other appliances directed to the main ends of its existence; but amid all these varied processes and movements, it is plain to be seen, that the animal life spins upon an *axis* represented by the brain and spinal cord; and above the music of all the little spheres which glide without discord through their varied orbits, we may recognize the voice of the directing principle, which reigns grand and peculiar, with firm but gentle finger upon the helm of life's microcosm.

If there be poetry in these words, the scientific truth of the statements they embody, cannot be impaired by the manner of expression. The facts are most palpable; and if our own period had done nothing more than recognize them, it would be justly entitled to distinction in the future annals of medicine.

Prevalence of Nervous Diseases.

It seems impossible, therefore, to deny the influence of an agency, which underlies the very base, and poises so delicately the column of life, in the production of diseased states, generally and particularly considered. This agency has long been recognized, to a partial extent, and "nervous disorders" are not a new revelation to the modern medical man. Whether diseases ensuing as a consequence of disordered innervation prevail to a greater extent in our own than in previous ages, is greatly to be doubted; though it appears quite certain, that in this day of mental strain and activity, we have developed a class of diseases, which may be said to be almost peculiar to excessive mental stimulation. During the age of muscle, as it might be termed,

when the conditions of life were hard and subsistence precarious, there was a constant drain upon the vital energy in support of mere physical existence; and bad hygienic conditions and modes of living, with bad and inappropriate food, worked out their penalties no less surely than now, when the brain is driven like a slave at the galley, and the body is pampered with a thousand luxuries; reminding one of a race between western steamboats, with the engines fed by barrels of grease and oil, each contestant being bound to win or rush to destruction in the attempt.

The Need of a Philosophy.

We are entirely destitute of a philosophy in this epoch of advancement. We cultivate neither philosophy of mind, nor philosophy of living. If some of the ornamental branches taught in our schools were dispensed with, and professorships covering the whole philosophy of life were instituted in their stead, we should soon witness the advent of a generation, who would not only know how to make the best of life, but prolong it to the utmost. As a nation we have many wants, which time must certainly supply, if not prevented by unwise legislation. But as individuals, our most urgent need is a philosophy; a philosophy of mind, a philosophy of morals, a philosophy of eating, and a philosophy of drinking.

Influence of the Nervous Centres in Disease.

There may be those who will deem the importance given in these pages, to the central nervous apparatus, as altogether exaggerated in practical results, if not in theoretical conception. It is an intelligent method, to begin the consideration of every problem involving the agency of the reasoning powers, by resolving it into its simplest terms; by canceling superfluous factors, and excising every irrelevant branch.

Such procedure is as applicable to the problems of medicine, as to any other line of inquiry. The author has made the attempt, in the preceding pages, to simplify to the greatest possible extent, the construction of the animal machine, to the end that a comprehension of its maladies might be rendered as easy as possible. He has said nothing of that higher essence, the mind; but has considered the purely animal life, as consisting of a material organ, acted upon by a principle, through which a certain form of energy is evolved; this energy animating the whole machine, and through its agency all the varied processes being carried on. He has considered all other organs and parts which go to make up the body, as accessory, either to the healthful maintenance and preservation of this central organ, or to the pleasure and enjoyment of the temporary life which it inspires. The philosophy of our time is too broad to be shocked at the expression of such views; and if it were not, the fact which is embodied in their statement, is much too stubborn to be lightly waved aside; and is only to be overcome by the development of other facts, which may divert the apparently logical consequence, to an entirely different conclusion.

As a substantial truth, then, the physician must regard the machine which he professes to put in repair, as essentially composed of three fundamental parts: *a structure which is acted upon; a principle which acts, and the product of the action itself.* The first agent in the process, is materially palpable to our senses; the last two elude our vision and pass our comprehension. The material and the immaterial here meet upon a dividing line; and from the fixed standpoint of the one, we are enabled to look off, with wondering eyes and longing impulses, into the profound and mystical depths of the other.

As a generalization from the preceding statements, all disease of the human system may be considered to involve, primarily or secondarily, immediately or remotely, the factors just mentioned. Under such a comprehensive view, of course, prime elements, and not the details of purely local phenomena, are taken into account. *Mens sana in corpore sano* is one of the trite expressions of medicine. An amendment which should declare, that a *sound nervous system makes a sound body*, would now come pretty near adoption, by the profession at large.

CHAPTER III.

Functional and Structural Divisions of Disease.

Great advances have been made in the study of the structure and functions of the nervous system, within a comparatively recent period; and therapeutic principles have been developed thereby, which have greatly inured to the benefit of the afflicted. But the field is vast, the working difficult, and progress must necessarily be slow. As yet our whole knowledge of the subject, is of the most general character; and has scarcely descended to the details of the momentous questions, involved in its thorough understanding. As a starting point of diagnostic effort, however, it is convenient and usual, to attempt a discrimination between morbid action of a *functional*, and that of a *structural* character. Elsewhere in these pages the author has raised the question, as to how far *persistent* functional derangement may exist, apart from structural alteration in some portion of the system, which gives origin to the functional aberration. The term structural alteration, must here be construed in its broadest sense, as implying an alteration of temporary or of permanent character. The blood, as an instance, may be altered in its structure by a deficiency of any of its constituents, as of the red globules; which deficiency, by appropriate means, may be remedied, and the structural alteration made temporary in duration and in effect. Or, the nervous system may be altered in structure, by the deficiency of any of the elements which compose it. This result is often seen as a conse-

quence of the practice of "Bantingism," through which the nervous system is starved of its oily constituents, and the most aggravated "nervous symptoms" induced thereby; all of which latter may be removed, if the needful element be supplied before it be too late. Thus it is, too, that the first ill results of excessive nervous exhaustion are brought about, by the rapid change or consumption of those elements, upon which nervous activity in part depends; as of the phosphorous compounds, etc.

Now, just here, there is a point which involves some of the most important therapeutic consequences, in the whole range of medicine. It is the point, where the iron has precisely the right temperature for being struck. A moment late, and the opportunity may be gone forever; and the remediable alteration of structure, may pass into the condition of irredeemably spoiled texture.

All motion in the universe implies change of state, and all activity, change of condition in the actors. This is no less true of the operations of organic bodies in general, than of any other forms of matter. The evolution and operation of energy in the human system, implies change of state upon the part of the material element, and hence there is a constant transformation of tissue, and an incessant demand for replacement or repair. Not only every act of voluntary motion, but also every act of intellection, involves metamorphosis of tissue. Further than this, though an individual lie supinely upon his back, and exercise no act of voluntary motion, and even let the brain run completely fallow, yet the amount of energy evolved by his twenty inspiratory acts, and seventy-five or eighty pulsations of the heart, per minute, to say nothing of the turning of all the little wheels of the economy, implies a change of structure, which latter, being unreplenished by the necessary fuel,

would soon yield to the combustion and fly away in smoke, leaving scarcely a cinder behind.

The Nervous Bankrupts.

Unfortunately perhaps, but in any event certainly, there is a limit to the natural reconstructive supply; and if undue demands are made upon the deposits of the bank, nervous bankruptcy, with all its entailments, is pretty sure to follow. Now the physician of our period has largely to do, in his daily labor, with the nervous bankrupts, both male and female; and he is excitedly called upon for a loan of vital energy, to tide them over the crisis into which unwise investments and extravagant speculation have plunged them. Whether they are to remain hopelessly insolvent, or once more become enabled to push their operations in the commodity health, must depend upon a number of circumstances, chief among which are those involved in the inquiry, as to whether the bankruptcy is *functional* or *structural* in character.

It is a remarkable and instructive fact, but one to which a little thought would naturally lead us, that the operation of the mental processes is marked by much greater activity of movement, and consequently by greater metamorphosis of tissue, than those in which simple mechanical motion is involved. A man may labor hard at some merely mechanical work, and not suffer a tithe of that exhaustion, which follows a much shorter period of brain effort, by the same individual.

CHAPTER IV.

Molecular Physiology of the Nervous Centres.

The interpretation of the well-known fact just stated, is attempted upon various bases, one of which starts upon the line before intimated, viz: that mental effort involves greater activity of movement, and greater metamorphosis of tissue in consequence thereof, than those processes which involve mere mechanical motion. The author cannot believe that this explanation covers the whole truth, if, indeed, it covers any portion of it. If, with improved facilities for determining the minute make-up of objects, at present beyond the ken of the chemist and histologist alike, it shall hereafter be shown that each portion of the nervous-axis, endowed with distinct functional characteristics, *has a distinctive chemical composition, or a distinctive molecular constitution*, based upon atomic arrangement, many facts in reference to these mysterious processes, which are now so incomprehensible, will be rendered comparatively easy of understanding.

Indeed, it seems impossible to avoid the above conclusion, in the face of facts which are already so well established, as to be quite beyond the reach of successful contradiction. If we admit that the influence resident within the nervous centres, is a form of *energy*, let it be called vital or by any other name, and that different portions of those centres preside over different functions; that here we have intellection and the highest acts of the mental processes; there, hearing; here, sight; there, taste; here, sensation;

there, motion; here a separate system presiding over nutrition, secretion, etc., then the conclusion follows as logically as that light makes day, and its absence, night, that the structure from which this energy is evoked, varies *in chemical or molecular constitution with the precise form of energy* (shall we call it motion?), *which is evolved by each particular function-centre.*

Whether this variation of constitution consists of a genuine difference in chemical composition, or is represented by differences of atomic arrangement, we know not. In the writer's view it is but a question of time, as to when the fact in general, if not in its details, shall be positively demonstrated. Let us ask the chemist to apply himself earnestly, to the solution of this question. Let him exhaust all the expedients of analysis; and if the nervous tissue elude the power of reagents, the microscope and the scales, let him appeal to the assistance of light and magnetism in accomplishment of *qualitative*, if he cannot reach *quantitative*, results. Would solutions of nervous substance be susceptible of circular polarization; and if so, in what direction would the plane of polarization revolve, in the case of different portions of the nervous structure? Can a segment of nervous tissue be made sufficiently transparent, to yield any results under the magnetic polarization of light, as discovered by Faraday?

Such expedients are mentioned only, as constituting possible resources of value, in the determination of many questions relating to organic composition in general. Let us invoke, then, every expedient of microscopy and chemical physics; let us call the sunbeam to our aid; let us borrow the armament of the laboratory, and illuminate the work with the electric spark. Out of all these means, there must certainly come an exact knowledge of minute structure,

which, as yet, we do not possess; a knowledge, which perhaps, may bring us face to face with what appears to be a great fact — the fact of distinct molecular characteristics, in different portions of the central nervous system.

If we once settle upon such a conclusion, then we are drawn still a step further by the irresistible logic of the facts, and are compelled to recognize each one of the cell-elements of the central nervous system, as forming an integral part of a cell-grouping, which gives origin to the form of energy inspiring each particular function of the economy. Thus, each cell has its characteristic form of energy, just as every atom of matter in the universe has its form of energy; and precisely as a molecule of matter represents in its energic or polar-form, the combined or aggregate polarity of the atoms composing it, so the cell-grouping of the nervous system which presides over particular functions, represents in the totality, the individual cells constituting the group.

Aside from the necessity of drawing such conclusions from the established premises, general analogies sustain them in a striking manner; and it would seem, that as every atom of cosmic matter has a characteristic and resident form of energy, which prompts it to unite chemically with some bodies, and to refuse union with others, so each atom making up a cell of the nervous structure, and each cell making up a group of cells, has a characteristic form of energy pertaining to it. The chemist, in dealing with matter, denominates this property, chemical affinity, and ascribes union to atomic polarity. We care nothing for names; it is the fact we are seeking.

The Condition of Insanity.

Under such an interpretation, many of the diseases of

the nervous system, whose causes are now hidden under the obscurity of present theories, would be susceptible of more rational solution. Especially would this be the case with that remarkable class of affections, which, with the force of the tempest, part the cables of the mind, and drift it from its moorings, into the waters of the unknown seas. Apart from the results following the accession of "acute" symptoms, the pathologist can find no structural change in the centres of thought, which may stand like finger-posts at the cross-roads, to point the path of danger. But it is impossible, quite impossible, that such aberrations from physiological function, as are presented by the unfortunates who fill the world's insane asylums, should exist apart from a structural change in the thing which is acted upon; or some inscrutable interruption to the agency of the thing which acts. Cases of complete, and perhaps sudden, recovery, will be cited against such a supposition; but if a supply of phosphorus and oil will often restore exhausted mental power, and the administration of iron will often replace the globular element of the blood, then we need be at no loss to explain an exceptional rebound from the anarchy, which follows the exit of an abdicated mind.

Dr. Thudichum's Analyses.

This observer has recently made some highly interesting statements concerning the chemical constitution of the brain, from which, as having a bearing upon the subjects above discussed, the author may be permitted to make a short extract:

Dr. Thudichum claims the brain to possess peculiarities in chemical composition which pertain to no other organized structure. He says (Public Health Reports, New Series, No. 3): "It consists essentially of three groups of

bodies. The members of one contain five elements, one of which is phosphorus, hence termed *phosphorized* bodies. The members of a second group contain four elements, amongst them nitrogen, but no phosphorus, hence termed *nitrogenized bodies.* The members of the third group contain only three elements, carbon, hydrogen and oxygen, present also in the other two groups, but no nitrogen or phosphorus. The phosphorized bodies are three — cephaline, myeline, and lecythine. The first possesses a tendency to be oxydized, *oxydizability.* The myelines are not easily changed by any agent or influence, and possess, therefore, *stability.* The lecythines easily fall to pieces, they are afflicted with *lability.*" After speaking at some length of the chemical behavior of these compounds and the physiological and pathological consequences thereof, Dr. T. continues: "All these processes are necessary consequences of the affinities of the phosphorized substances, and these being known, the phenomena could be predicted, if they were not sufficiently known as phenomena, though hitherto destitute of an explanation. . . . These few examples show that the acquisition of chemical statics leads almost necessarily and very easily to mechanical dynamics of the brain, and these will in their turn furnish data for physiological and pathological conclusions." Dr. T. also treats of the other principles; those of the nitrogenized and oxygenized classes, in a most interesting manner.

CHAPTER V.

Functional Consequences of Excessive Mental Activity.

The logical effects of an excessive requisition upon the brain, for the evolution of the *mental energy*, through which the equilibrious adjustment between metamorphosis of tissue and replacement of structure by the normal processes of nutrition is disturbed, are presented to the physician every day, in the cases of those who represent, in varying degrees, brain exhaustion. The symptoms characterizing these cases, are of the most marked description. The general feeling of *malaise*, of weariness, of indisposition to exertion, of inability to make any bodily effort without prostration, incapacity to perform any mental labor, loss of the power of consecutive thought, indigestion, with its accompanying pains in the region of the heart, leading to a belief in existence of disease in that organ, increased respiratory movement, impaired sanguification, perversion of the moral faculties as evinced by peevishness, irritability, apprehension and gloom; and finally, loss of memory, loss of sleep, and impairment, and perhaps total loss, of the sexual power; all go to make up a case not difficult to recognize as the legitimate offspring of our fast age, with a cracking of the timbers of the brain from violent use of the mental structure.

When we meet a case presenting any or all of the symptoms above mentioned, we invariably examine the various organs for structural alteration. The lungs are found to be all right; the heart all right; the stomach all right;

the kidneys all right; and we are happy in being able to assure the sufferer that his whole trouble is purely of a "functional" character; at which assurance he generally heaves a long-drawn sigh of relief. In giving such an assurance, the physician has no intention of deceiving the patient; and in one sense, he does not deceive him. He has, truly, a *functional* disorder, but it depends upon a *structural* change; and the vital question with the patient is, as to whether the structural change be susceptible of remedy or not.

Excessive activity implies excessive evolution of energy, which latter, in its turn, implies excessive metamorphosis — destruction is the usual word, but it is not the proper one — of tissue. Now, looking at the chemical constitution of the brain in health, while directing cessation of brain labor, we give the class of patients spoken of, phosphorus and oil, or food which contains them; iron, strychnia, perhaps, and possibly we may direct the use of electricity. We feed him on fish, oysters, unbolted bread and all sorts of prepared foods, looking chiefly to the phosphatic elements they contain. These measures may happily succeed in *restoring structure*, and bright-eyed health may come singing back to the deserted mansion. Unfortunately, they do not always succeed, and positive morbid action induces a no less positive structural change; when the lights go out, one by one, until darkness envelops the dwelling, and silence reigns, as profound, as that which, sooner or later, settles upon the once festive scenes of a banquet hall.

Consequences to the Female System.

In the foregoing remarks, we have been considering more especially our male patients; but most unhappily, our female friends are in no wise exempt from the maladies springing from disordered innervation. From differences in habits

and occupation, and some marked differences of physical construction, the female is liable to aberrations of the nervous energy, to a greater extent than the male, though in the large majority of cases, differing wholly in class or kind.

The instances in which the female is called upon, to undergo the same mental strain and exhaustion as the male, in the competitive struggle for life's trinket-premiums, are not few to be sure; but both have an inscrutable peculiarity of nervous construction related to the circumstance of sex, which neither the one nor the other, can evade or overcome. This circumstance creates differences, not only of general *physique*, but, also, of general nervous characteristics. The physician sees fewer women than men, with exhausted brains from mental overwork; but he sees more women than men, with *general* nervous exhaustion, and as a consequence, with feeble vitality. Hyperfecundation, hyperlactation, marital and maternal solicitudes, overtaxing the emotional functions, overwork by the poor, and overindulgence by the rich, add fuel to a flame constantly struggling toward an outbreak.

"Oh, doctor, *can* you not give me something to make me sleep; will you not give me something for my backache; can you not cure my headache, or give me something for this intolerable nausea?" "Why, the organs are all sound," says the doctor; "the uterus is all right, as to position, structure and function; everything is right"—save one thing; which latter will soon make everything else all wrong. If it were a mere break in the wires, the matter would be a short and a slight one; but the central apparatus itself, is uttering notes of warning, which bodes no end of trouble, if it cannot be reached by remedy. It were fortunate indeed, if the morning of *molecular pathology* had fully dawned, in order that we might soon witness the advent, of the day of MOLECULAR THERAPEUTICS.

CHAPTER VI.

Therapeutics of the Nervous Diseases.

The author has no purpose to enter upon an extended discussion of the treatment of these diseases, of course, in a volume like the present. The literature of the subject is constantly increasing, and is already enriched by a large number of sterling works. Many remedies are in vogue, which cover some of the principles herein laid down. Phosphorus, oil, nutrients, etc., contribute to *structural accretion* and upbuilding; and thus far, thus good. In relation to female sufferers, Dr. S. Weir Mitchell, of Philadelphia, has elaborated a system, which he interestingly describes in his little volume entitled "Fat and Blood, and How to Make Them," the title of which, however, might, not inappropriately, be changed to that of "Nervous Structure and Vital Energy, and How to Supply Them." The system is embraced under the following measures: "Seclusion, certain forms of diet, rest in bed, massage (or manipulation) and electricity."

The philosophy of this treatment is admirable, and in many cases is, without doubt, conducive to the best results. *Structure* is added by the process, and the *energy of food elements* is likewise contributed to the restorative effort. Whatever good results may accrue from the hygienic regimen and discipline of water-cure establishments, flow from the same general principles.

But in these affections, as in those of the infectious diseases, the demand is for *specifics*. Some of the remedies,

indeed, with which we meet disorders of the nervous system, are specifics to a partial extent; specifics in the sense of supplying a deficient element of structure, to the thing "which is acted upon." In the effort to restore structure we are dealing with one of the fundamental parts of the machine, as defined in the preceding pages. There are two other factors, according to the author's view; one of these is a "principle which acts," and the other, the "product of the action itself."

Suppose we succeed in fulfilling the first indication, by restoring to its typical state, the structure of the nervous centres. Does it follow as a necessary consequence, that the other parties to the contract, stand always ready to make good their own obligation in the case? It would certainly seem not. There is an agent concerned in the transaction, through which, as has heretofore been pointed out, the whole business is done; and if it be certain that particular operations of the nervous centres involve a metamorphosis of the *phosphatic* and other compounds, it is just as certain that they involve the assistance of *oxygen*, through which to accomplish it. The method of these processes has been sufficiently dwelt upon in a previous portion of this volume, and need not be rehearsed, further than to say, that as this agent has a function to perform, which is linked with the red blood-globules, the "structure" of the blood itself must correspond in typical integrity, with the organ representing the other element of the process.

Now, one thing appears very plain: that if deficient structure of the nervous-axis, in whole or in part, exist to the extent of involving loss of function, then of necessity there must follow a *proportionate decrease* in the general supply of the *oxygenating* element or principle. And just

as an organ shrinks in volume from lack of use, be the cause whatever it may, so a diminution of nervous function produces, in a mathematical ratio probably, a diminution of the *oxygen-carriers* of the blood. Hence, although we may be deceived by the general appearance of the subject, into a belief that the last-named element is in the normal proportion, the two morbid conditions go hand-in-hand, and are incapable of separation. All of these eminently vital processes are so interdependent, running, as the author has elsewhere expressed it, in a circle without beginning or end, that it seems impossible to implicate one of the segments, without comprehending the whole chain of events.

But there exists in the point just made, a fact of the greatest importance, in the therapeutics of all these diseases. If phosphorus and oil are essential, oxygen must go with them; and if the latter is to be sent on a message, iron must be dispatched as its carrier.

It seems difficult to overestimate the influence of disorders of the central nervous-axis involving a disturbance of "energy," in the production and sustenance of other diseases. The fact is familiar to every practitioner, that "local" affections are often susceptible of cure, only, through "general" measures. This truth finds frequent and emphatic illustration in those rebellious affections of the uterus, which resist every local effort we may bring against them, and only yield under the conjoined effects of general and local treatment; as well as in those troublesome symptoms, grouped together under the generic name, "*dyspepsia*," which symptoms, in a large proportion of cases, result from a disordered innervation, and from no fault of the stomach itself. Such cases, after having stood out successfully against the mineral acids, the vegetable bitters,

strychnia, carbolic acid, pepsin, diastase, and the dozen or more combinations intended to relieve the stomach of any agency in the digestive process, will often get well as if by magic, under the effects of phosphide of zinc, and oil, with iron and chlorate of potassium administered upon alternate days.

There seems reason for believing also, that many hyperæmias and passive congestions, both of the nervous centres, themselves, as well as of other organs, result primarily from a deficiency of the vital energy; through which deficiency the vaso-motor system of nerves lose a portion of their tone, and the inhibitory function is thrown off its balance. If we are fortunate in being able to determine the real nature of such cases, we may relieve them by remedies and measures directed to the general upbuilding of the nervous power, not so quickly, to be sure, but as certainly, and more permanently, as the application of electricity to the cut end of the cervical sympathetic, will dispel the general blood stasis upon the side of the head, invariably produced by section of that nerve.

The foregoing remarks, however, touching the therapeutics of nervous diseases, embrace no suggestion as to remedies of a positive class or character; nor was it the intention of the author, that his running commentaries should have any other purpose, than that which might tend to develop a line of thought, through whose logic, others more fitted to the task than himself, could arrive at conclusions of positive and substantial value.

The great demand of our suffering age is for the development of remedies or plans of medication and general management, which, beginning at the beginning, shall make an alliance with the very Oracle of the Temple; which shall contribute material structure, and supply "energy";

not energy as meaning physical strength alone; but energy as implying, at once, the subtle power and the delicate oil, through which the wheels of life's machinery move swiftly and without a jar. To him who may develop principles, which shall be potent to substitute strength for weariness; to cast out pain and call back repose; to beckon sleep, unmixed with the thick-coming fancies of the opiates, to the staring eyes; to

> "Raze out the written troubles of the brain.
> And with some sweet oblivious antidote
> Cleanse the stuff'd bosom of that perilous stuff,
> Which weighs upon the heart,"

there will be erected a monument higher than the steeple of St. Paul's, and more enduring than the Pyramids, which, "doting with age, have forgotten the names of their founders."

CHAPTER VII.

Conclusion.

With these remarks, the author brings his book to a close. He could easily have amplified and swelled it, to double its present proportions; and by greater elaboration have anticipated the objections, with which many of his views may be met. His present purpose, however, has partaken largely of the suggestive character; and if he shall succeed in loosening any of the cords which tie so many of us down to a too strict *vitalism* on the one hand, and an ultra-chemismus on the other, whereby we may be enabled to enlarge our field of vision, one of his chief objects in writing these pages will have been accomplished.

Slowly, perhaps, but surely, we are waking to the true basis of our physical being; and we are coming to understand, that the physician in his practice, has largely to do with the physical forces and agencies of nature. Old deductions founded upon false premises, are vanishing like a mist before the morning sun. But a few years since, we deliberately robbed a sick man of the energy temporarily lent him by nature, for his terrestrial life; the physician of the future will not only conserve that which the man hath, but see that more is given him. In dealing with fever, he will recognize a physical impetus behind it. In suppressing a hemorrhage, he will abandon the use of cold as a sedative and astringent, in a large class of cases, and resort to heat; whereby he elevates the local temperature excessively, and transmuting surplus heat into motion, produces contrac-

tion of the muscular fibres of the bleeding vessel, and permanently arrests the hemorrhage.

And while he sits at the bedside of his patient, and makes an ideal estimate of the sick man's vital power in *foot-pounds*, there need be nothing in his theory or in his practice, to conflict with the hope and belief in an immortal spirit of the earthly tabernacle, whose essence is of the Great Unknown.

ADDENDUM.

Concerning the Source of Energy.

In penning the foregoing pages, the author has endeavored to keep the present volume within the limits which may best insure its careful perusal by the busy practitioner, while trusting to a future opportunity to more fully illustrate his views upon those subjects, of a purely physical nature, herein so hastily touched upon. Now that the book is in print, he realizes that his effort at great brevity must subject him, upon some points, to misinterpretation, though he hopes, it may be to no serious extent.

Treating so exclusively and unmistakably of the human subject, the author has not deemed it necessary in speaking, as he so often has occasion to do, of the "animal," the "animal life," etc., to restrict his references thereto, by specific designation; and much less to discriminate between vertebrate and invertebrate construction — discriminations

which would be necessary to scientific accuracy, were the subject of life in general under discussion.

Upon one topic, however, he must ask a parting word. In treating of the source of energy, upon page 74, the author makes, what will be considered by some, perhaps, a fanciful speculation, which intimates that the solar bodies derive their energy from a central source, and therefore have no *inherent* light and heat. This central source is designated as "the pivot of the universe." The construction of the paragraph seems liable to convey the impression, that the author entertains a belief in the transmission of energy from this central source to the solar bodies, in the *forms of light and heat*, as we receive the latter from our sun. Nothing could be further from his intention than this. If there be any basis for such a supposition as the author makes, it does not follow, of necessity, that the energy is imparted in those forms to the solar bodies. The great centre of cosmic energy, to borrow a conception from Kant and Lambert, may have no appearance of luminosity, and yet impart energy to its satellites in a form, which afterward assumes the energic modes of light and heat.

The idea is advanced as a mere suggestion, with no desire to make an argument upon a question, which, as involving an expert knowledge of the sidereal or stellar universe, does not belong to the author's province.